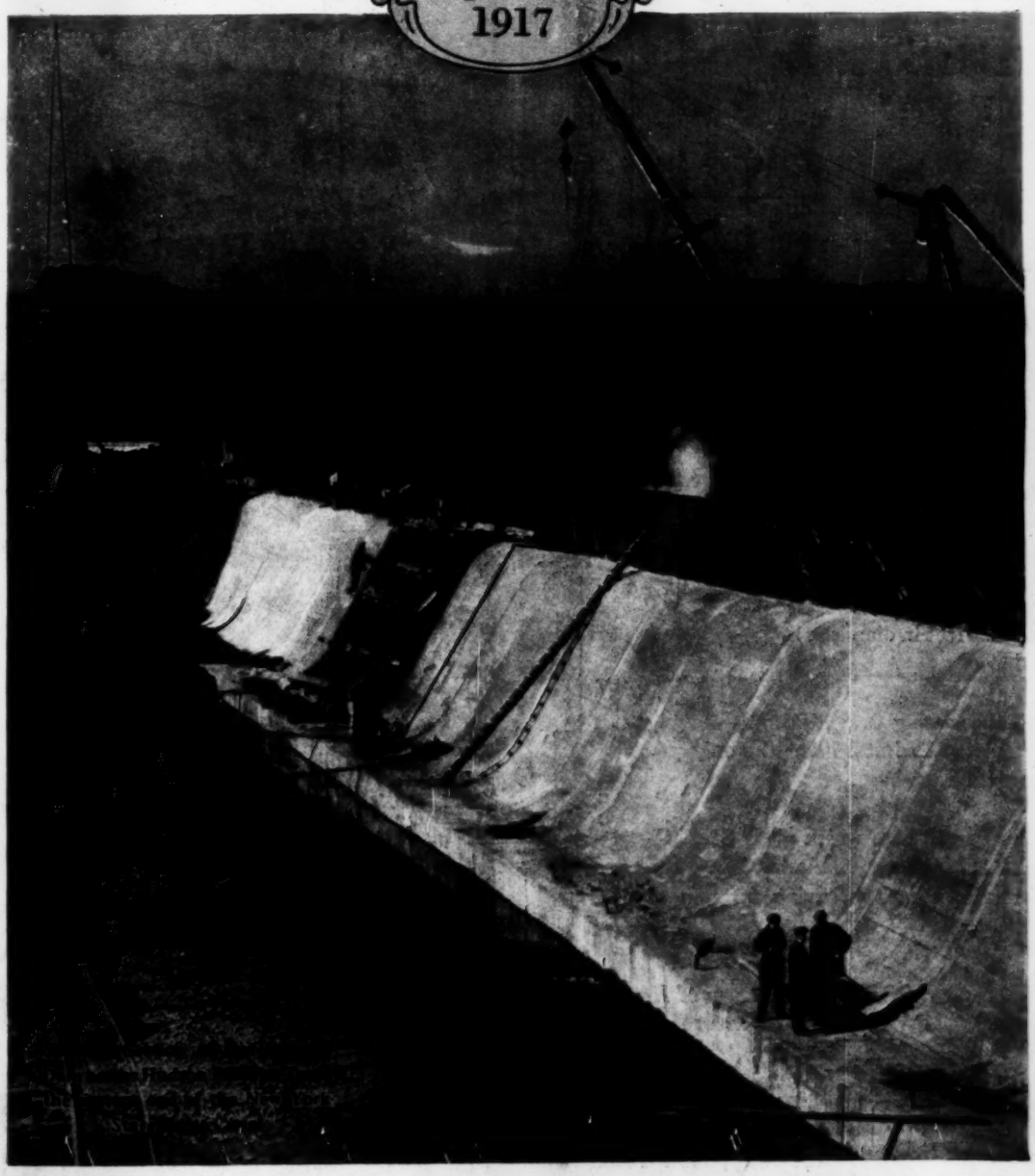
In this issue: Engineering Schools Work for Preparedness—A Countrywide Survey of Engineering Prospects—
The Engineer's Opportunity in Humanizing Industry

Engineering News-Record

APR 13 1917
UNIV. OF MICH. LIBRARY

A Consolidation of Engineering News and Engineering Record
McGRAW-HILL PUBLISHING COMPANY, INC.

April 12, 1917



Cover Reproduced by Courtesy of MacArthur Concrete Pile & Foundation Co., 120 Broadway, New York City

"Superstrength"

How it is Built Into the PEDESTAL PILE

First, a core and steel casing are driven to the required depth.

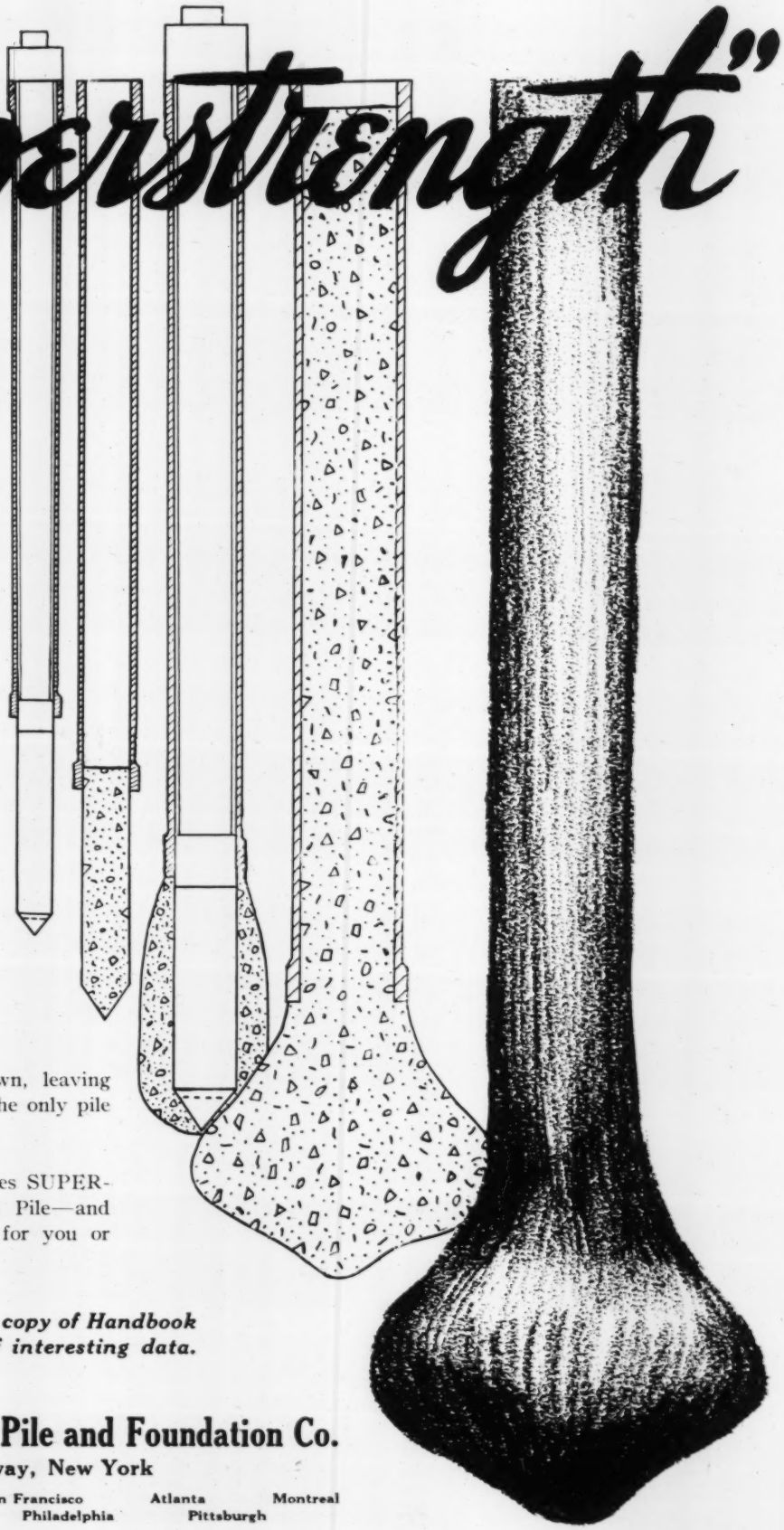
Second—the core is removed and a charge of concrete is dropped in.

Third—the core is used as a rammer to compress the concrete into the surrounding soil.

Fourth—this process is repeated until a Pedestal Base about three feet in diameter is formed.

Fifth—the casing is withdrawn, leaving the completed Pedestal Pile—the only pile with an enlarged base.

It is this spread base which gives SUPERSTRENGTH to the Pedestal Pile—and there results a money saving for you or your client.



Write for your copy of Handbook N—64 pages of interesting data.

MacArthur Concrete Pile and Foundation Co.

120 Broadway, New York

Chicago Detroit New Orleans Boston San Francisco Philadelphia Atlanta Pittsburgh Montreal

Engineering News-Record

A CONSOLIDATION OF ENGINEERING NEWS AND ENGINEERING RECORD

A Weekly Journal Devoted to Civil Engineering and Contracting

PUBLISHED BY MCGRAW-HILL PUBLISHING COMPANY, INC.

Volume 78 NEW YORK, THURSDAY, APRIL 12, 1917 Number 2

Design of Milwaukee's New Sewerage System Based on Conditions 35 Years Hence

Methods Explained for Determining Future Population, Area, Domestic and Storm Water Run-off—Pressure Tunnel Conduits Have Been Planned

By CARL H. NORDELL

Assistant Engineer, Milwaukee Sewerage Commission

MILWAUKEE has long had a sewage-disposal problem on its hands. The growing community had hardly attained respectable proportions before the three small and sluggish streams into which all the sewage was poured were overloaded with their burden of filth. Not only did their stench assault the nostrils of the passerby, but their waters polluted the lake and thus contaminated the public water-supply. In the early days the chief concern of citizens was to eliminate the smell rather than to improve the wholesomeness of the water. In 1879 a commission of prominent engineers, E. S. Chesborough, Moses Lane and George E. Waring, was instructed to "devise a means for abating the river nuisance." A report was submitted in due time, but no action was taken to carry out its recommendations. Some six years later George H. Benzenberg, then city engineer, advocated flushing out the Milwaukee River (Fig. 1) with clean water pumped in from the lake. This project was bitterly fought, but proved a brilliant success the instant it was put into service. A few years later the Kinnikinnic was similarly flushed, but the third river, the Menomonee, could not be so readily handled, as it ran straight inland instead of more or less paralleling the shore of the lake and would hence need a very long clear-water tunnel to serve it.

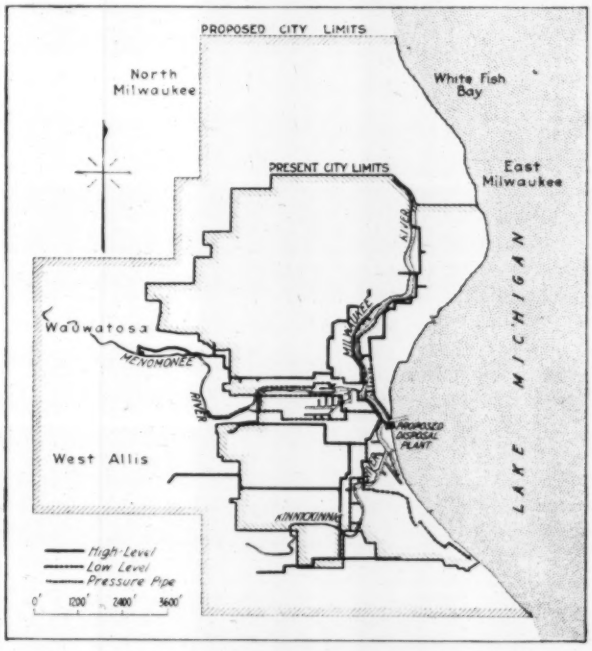


FIG. 1. LAYOUT OF MAIN COLLECTING SEWERS, MILWAUKEE, WIS.

Present and prospective 1950 city limits, high-level and low-level sewers and pressure conduits in tunnel are shown

In 1909 a very able commission consisting of John W. Alvord, George C. Whipple and Harrison P. Eddy, was appointed to study the problems of cleaning up the Menomonee and eliminating danger to the water-supply as well; for naturally flushing had helped but little in solving the latter problem. The commission made an elaborate and exhaustive report, recommending sewage collection and treatment, filtration of the water-supply and flushing of the Menomonee.

Again no action was taken, but four years later the present Milwaukee Sewerage Commission was appointed under legislative enactment that took the whole project definitely out of politics. George H. Benzenberg became chairman, and the commission selected T. Chalkley Hatton as its Chief Engineer. Preliminary work and studies were under way early in 1914. As the system of collecting sewers was more or less independent of the method of sewage disposal, which would not be decided upon until the findings of the testing station were complete, it was decided to tackle its design as soon as possible. This collecting system would consist of intercepting sewers to cut out the flow of the common sewers, with which the city was very fully provided, just before it reached the rivers. The first essential in fixing upon a design was to establish the time limit for which the interceptors would be expected to serve the needs of the city. It would clearly be unwise to construct them large enough for immediate needs only; neither would it be advisable to make them so large that the greater part of their capacity, and hence the capital expended in building them, would lie idle for many years to come.

It was not possible to determine precisely the economical time limit; but taking everything into consideration, it was thought best to plan for no more than 35 years ahead, or for the maximum sewage flow of 1950.

The probable 1950 population of Milwaukee was predicted along the lines more or less familiar to all. A

curve was plotted showing the previous growth of the city and also the growth of other cities after passing the population Milwaukee now has. Admittedly, no great accuracy can be claimed for this method, but as a matter of fact none is needed. Any discrepancy between the predicted growth and the actual growth merely results in the capacity of the interceptors being reached a little before or after the specified time; and as this time is more or less arbitrarily selected anyhow, no great harm is done.

Estimating the future distribution of population is not quite so simple. The writer tried to gather data bearing upon this problem, but did not meet with much success. There were, it is true, census figures by wards back as far as 1850, but upon investigation it was found that the industrious city fathers had seldom failed to change the ward boundaries in the census intervals. An attempt was made to retrace the old boundaries, but in all except a few instances so many difficulties were met with that the

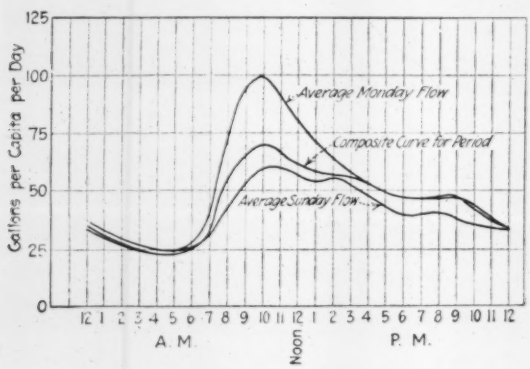


FIG. 2. TYPICAL SEWER GAGINGS, MILWAUKEE RESIDENCE DISTRICT

Average hourly record for two weeks' continuous period in a district having 60,000 population

figures would have little weight. The few exceptions did seem, however, to indicate that on the average the numerical increase in population was about the same year by year until the saturation mark was reached, and that after that it slowly receded.

This rule does not conflict at all with the idea of rapid development in newly opened districts. An increase of five per acre where there were only two per acre before is a striking growth. It is a 250% increase. But the same numerical increase of five when the former population was 50 is an increase of only 10%, and as such is hardly noticed. At any rate the uniform numerical increase rule has the great merit of simplicity and is probably near enough to the truth for all practical purposes.

The 1950 distribution of population was therefore very readily arrived at by prorating the expected increase of population over the entire city, excluding of course the industrial and commercial areas, and adding this increase to the existing population of the drainage districts as found by making a count of the houses on the Sanborn insurance maps. Where, however, it was found that the prorated increase would bring the 1950 density over 75 per acre, which is now the limit in Milwaukee, the density was held at that figure and the extra population again prorated over the rest of the territory.

As a city grows in population, its area also increases. The increase in area is best found by establishing upon the map the probable future boundaries. In the case of Milwaukee there would seem to be little doubt that the towns and villages immediately adjacent to the north and west will have been annexed by 1950, and the future boundaries were accordingly extended to include them.

The present industrial and commercial areas can readily be defined. The directions in which they will expand are more or less fixed by certain natural and economic features in Milwaukee, so that their future boundaries are not so uncertain as might otherwise be the case. The area of each district was increased about in proportion to the expected increase in the population of the city; but it was thought best to be rather liberal in this respect, as the run-off in these districts is high and it is better to err on the side of safety. With the population, area, residential, industrial and commercial districts of the future city estimated, it remained to fix the amount of run-off that would be contributed per unit of population or area.

Determining Present and Future Run-Off

The run-off from the residential district is dependent upon the population and the per capita consumption of water, for only a very little of the water used in dwellings does not leave through the house drain. Fortunately, the records of the Milwaukee Water Department give very accurate and detailed information on the use of water. Practically all services are metered, and the consumers are tabulated under separate headings. The "residential" consumers average 31 gal. per capita per day.

This figure, of course, gives no indication as to what hours of the day the draft of water is greatest and how high the peak load is. For these data recourse must be had to sewer gagings. The gagings made were rather more complete than usual, for the data were gathered so easily and cheaply by installing weirs and self-recording gages that the flow of practically all the large sewers was measured.

Rectangular notch weirs were installed by attaching them to transverse braces let into holes previously cut in the brickwork of the sewer. The braces were installed first and the complete weir cut to fit the invert then dropped in front of them. The head of sewage over the weir was recorded by an automatic gage set up in the manhole; the air tube connecting with the pneumatic pressure chamber was set in the still water above the weir. Both Bristol and Foxborough liquid-level recording gages were used with the dial graduated in inches and turning once in 24 hours. Practically the only attention required was inspection and changing of charts once a day.

Groundwater Increases Sewer Flow

Averaging the results in the residential districts, it was found that the per capita run-off was 64 gal. As not over 31 gal. per day is sewage proper, the remainder must be attributed to groundwater. The result is higher than was expected and considerably more perhaps than the assumed groundwater flow in many cities. The maximum Monday flow, deducting the groundwater, was found to be 81 gal. per capita, or about 2½ times the average flow.

These figures, however, represent only the present use of water; and it is safe to assume that, as time goes on, the use of water, in residences at least, will tend to increase. During the four years that the Water Department records have been tabulated the domestic consumption has increased 3 gal. per capita, and the increase has been steady, year by year. There is considerable question, naturally, as to whether this increase would be maintained for many years or whether a certain saturation, as one might perhaps too aptly say, would soon be reached.

In order to get an idea of what the freest possible use would amount to, study was made of a high-class apartment-house district, where the people using the most water might be expected to reside and where they would have no incentive to give heed to the meter, as the landlord pays the bill. Here the consumption was found to be 60 gal. per capita. This, then, might be taken as the limit in the residential use of water.

It is hardly likely, however, that even by 1950 the entire population of Milwaukee will be living in high-class apartment houses; for probably not even the Socialists can bring about the millennium so quickly. It was thought better, therefore, to fix upon a somewhat lower amount, and 50 gal. per capita was taken as the 1950 figure. It was further assumed that the same relationship between average and maximum flows will obtain then as now, which placed the 1950 maximum at 125 gallons.

Commercial District Consumption

There are no sewers in Milwaukee that serve a district wholly commercial. It was therefore necessary to base the run-off figures on the water consumption alone. Three representative commercial blocks were chosen, and hourly meter readings of all the water services were made for several days. These figures were used to establish the ratio between the average daily flow and the maximum rate of flow. The Water Department records were then compiled to obtain the average daily consumption of the whole commercial district; and this figure, which differed somewhat from the average of the three blocks, was used as the average daily run-off. The maximum rate of run-off was calculated by assuming the average to maximum ratio for the three blocks to apply to the entire commercial area.

It was found best to compute the water consumption on the unit of floor space in the buildings. The average floor space per acre was compiled from the Sanborn insurance maps and the run-off per acre computed.

As the city increases in size, the height of the buildings will naturally increase and hence the run-off per acre. The ratio of present to future run-off was assumed to increase in proportion to the population. This placed the maximum rate of run-off for 1950 at 60,540 gal. per acre per day.

Industrial-District Run-Off a Problem

The industrial district presented a problem all its own. Small portions of this district show a very high rate of run-off per acre, if they happen to be occupied by some industry using a great deal of water. For instance, the land occupied by a brewery contributes 137,500 gal. per acre per day, whereas the metal-working shops and foundries produce only 11,000 gal. per acre per day.

At present, of course, the location of the excessive water users is known, but what of the future? Clearly, it is well within the bounds of probability that certain sewers serving parts of the future industrial area will be called upon to carry off very high rates of run-off. It is safest, therefore, to provide for high run-off from any particular portion of the industrial area; but as a larger and larger part of it becomes tributary to the sewer, the run-off rate per acre can be reduced, as in all probability industries consuming but little water will pull the average down. Accordingly, a sliding scale was adopted, the run-off per acre decreasing as the acreage increased. This was not used blindly; but where industries using much water were known to be located, separate allowance was made.

Many industries depend largely upon driven wells for their water-supply. On investigation it was found that the total flow of the wells just about offset the water lost in manufactures, making steam, etc., and the industrial run-off was considered equal to the industrial city-water consumption. The figure is 9350 gal. per acre per day, or 36.2 gal. per capita.

This figure is the average daily flow. There is no sewer serving a purely industrial area to establish the relationship between average and maximum flow, and the industries varied too much to make detailed hourly meter readings. The data gathered, however, combined with data from other cities, indicated that an assumption that the maximum flow is twice the average would be about right. Hence the maximum rate of run-off was placed at 18,700 gal. per acre per day for the entire industrial area and higher than this for small portions of it.

To the volumes of sewage proper running off from each type of district must be added the groundwater infiltration through sewers and house drains. It was established by the sewer gagings in the spring that the maximum rate of groundwater infiltration averaged 1620 gal. per acre per day, over nearly one-half the area of the city. This seems very high, but the figure rests upon evidence that cannot well be controverted. The explanation may lie in the many old deep tunnel sewers under a high head of groundwater.

As Milwaukee is sewered on the "combined" plan, the sanitary sewage is diluted with storm water in time of rain, though perhaps "diluted" is a misleading term. Anyone who has watched the first of a storm come down a sewer would be inclined to say strengthened instead. Nevertheless, the greater part of the storm flow must be bypassed directly into the rivers, for the building of interceptors to carry it off, to say nothing of a disposal plant to treat it, would be altogether too expensive an undertaking.

Fixing Storm-Water Allowance

The question then arises as to how much, if any, capacity should be allowed in the interceptors for storm water. While it is impractical to carry it all off, may it not be advisable to provide for some part of it, especially so that the "first flush" of storm water, which was found especially foul, might be passed through the treatment works?

A strict analysis of all the conditions surrounding the problem would be exceedingly difficult and tedious, not to say impossible, to make. It developed, however, that if in the commercial and industrial districts the capacity of the interceptors were enlarged by 37%, the cost would be increased about 15%; but the time when the inter-

ceptors were taking the entire sewage flow would be increased but 1%. This seemed a disproportionate expenditure for the gain, and no extra allowance for storm water was made.

In the residential districts, on the other hand, where the dry-weather run-off was not so high and the disproportion less marked, allowance was made for 0.01 in. of rain per hour, 50% running off, or 3200 gal. per acre per day.

With the run-off from the three types of area fixed and the boundaries defined upon the map, it was a simple matter to compute the volume of sewage that the interceptors must accommodate. A number of alternative locations were made, and comparative estimates of cost were made to determine the most economical route to follow.

The site of the disposal plant had not then been selected. The choice lay between two certain tracts of land, and the decision hinged to a great extent upon the cost of carrying the sewage to them. Two general plans

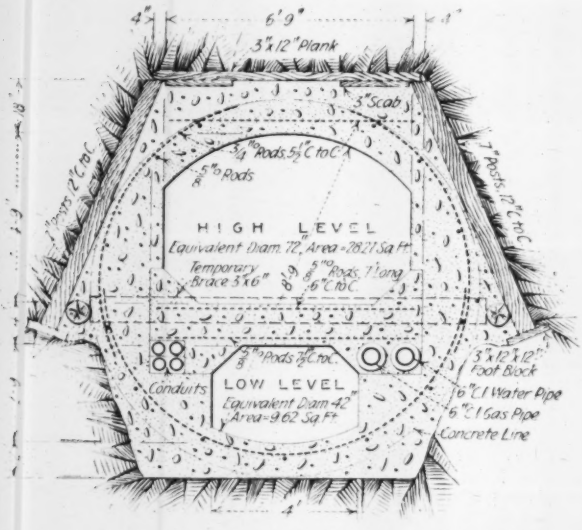


FIG. 3. TYPICAL CROSS-SECTION OF DOUBLE SUBAQUEOUS TUNNELS, MILWAUKEE, WIS.

for the interceptors were therefore laid out and designated as the "Jones Island Plan" and "Chases Tract Plan." Further, each of these was subdivided into a "Low-Level Plan" and a "High-Level Plan." The low-level plan called for one set of sewers and the pumping of the entire flow of the city at the disposal plant; the high-level plan called for a low-level and high-level system of interceptors, which would save the pumping of about two-thirds the flow.

Jones Island High-Level Plan Adopted

The plan eventually decided upon was the Jones Island high-level plan. The preliminary estimates of cost showed up in its favor, but there were in addition other reasons for its acceptance. First, the Jones Island tract was more suitable for the disposal plant on sentimental grounds, for the competing site was surrounded by residences whose owners naturally were very bitter against the project. Second, the high-level plan greatly decreased the size of the necessary low-level sewers in the business district, thus speeding their construction and minimizing the obstruction to traffic. Third, the construction program could be much better arranged on the high-level plan, as the building of the high-level sewers could be deferred for some time; while the immediately constructed low-level sewers temporarily carried the entire flow to the plant.

The adoption of the high-level plan made necessary some rather long pressure pipes and inverted siphons. The longest is the west-side pressure pipe, which together with the inverted siphons over the Milwaukee River and the harbor mouth is 8500 ft. long. In establishing the size of these pressure pipes and siphons the velocity when put into service was made the controlling feature. It was desired that even at first their velocity should not be less than that of the gravity sewers which discharge into them. To illustrate: The interceptors are designed to have a minimum velocity of 2.5 ft. per sec. when filled to capacity. When placed in service, they will not be filled; and hence the velocity will be somewhat less—2 ft. per sec. All pressure pipes and siphons were accordingly to have 2 ft. per sec. velocity when placed in service.

As the final run-off rate is four times greater than the initial and as the entire bore of the pipe is filled at all times, the ultimate velocities are four times as great, or 8 ft. per sec. This is the flow in times of storm; it will not ordinarily be over 6 to 7 ft. per sec., but the initial velocity of 2 ft. per sec. will be realized each day for the four or five hours of high flow.

When the available fall was not enough to produce these high final velocities, the standard was not lowered, but a double line was provided, with the idea of using only one pipe to start with and bringing the other into service as the flow increased. In most cases the construction of one of the two lines is deferred until needed; but where both are built at once, it is not by any means intended that the second pipe shall come into service automatically.

The latter plan is fairly common practice, but it seems to the writer that nothing could be more mistaken. There is no way, of which the writer is aware, to prevent the second line from taking the surplus of any flow that slightly exceeds the capacity of the first, and this slight surplus does not provide a self-cleansing velocity. As a consequence the second line soon silts up.

The Milwaukee double pressure pipes will have the second member shut off by gates until the sewage flow has increased to such a point that both lines can be run simultaneously. Care must be taken when two lines are provided that at least double the minimum velocity will be realized before the second line comes into service. For instance, if 2 ft. is taken as the minimum, the pipe must have sufficient fall to develop twice that velocity, for otherwise when the second pipe is thrown into service and the velocity cut in two it would fall below the allowed minimum.

Pressure Tunnels with Two Conduits Used

Wherever possible, low-level and high-level river crossings were made at the same point with the idea of using a double-barreled tunnel. There are three of these crossings, and the tunnel sections were designed with more of an eye to ease of construction than good hydraulic properties, for it happened that at those particular points plenty of fall was available. A typical cross-section is shown by Fig. 3.

After the layout of the intercepting sewers and pressure pipes had been completed, it was decided to proceed immediately with the detailed construction plans of the Milwaukee River low-level interceptors. These sewers paralleled the river and drained the business section of the city. The west-side sewer was siphoned under the river at Detroit St. and there joined the east-side sewer.

To Divert Every House Connection

Both of these sewers are placed in the streets nearest to the river, with the exception of a part of the east-side sewer, which is two blocks back for a portion of its length in order to get it into ground more suitable for tunneling. Tunneling has been resorted to wherever practicable in order to avoid disturbance of traffic.

The streets in which these interceptors are built are not marginal streets, but are about half a block back from the river bank. The chief engineer ruled that each and every house connection must be diverted from the river, and it was accordingly necessary to place the intercepting manholes near the sewer mouth and run back half a block or so with a lateral to the interceptor.

These contracts were let early in 1915, and since then additional sewer contracts have been let as money became available for construction. At first, bids were called for on alternative sections of monolithic concrete or concrete invert with brick arch, but owing to the high price of labor and materials the brick section proved so unattractive to contractors that it was omitted from subsequent lettings.

Heavy Cross-Sections and Much Concrete Used

The tendency in the design of the sewers has been to use rather more massive cross-sections than usual, but to employ steel reinforcing sparingly, if at all, except where it cannot well be avoided, as in flat slabs and pressure pipes. This tendency has been marked in the later contracts, as most of the sewers are to be built in tunnel where the placing of steel is expensive and where the entire bore is in any event backfilled with concrete.

Wherever terra-cotta pipe has been used, it was completely surrounded with concrete. It was thought that, as long as the principal construction cost lay in opening the street and making the excavation, it would be poor economy to save on the little concrete required to insure the pipe absolutely against failure. As it happens, most of the terra-cotta laterals have been laid in tunnel; and as the backfilling has been entirely of concrete, the structure is exceptionally massive.

Very little has been done in the design of interceptors to keep out the surplus storm water. One type of novel design, for which the writer pleads guilty under extenuating circumstances, seemed very promising when first tried out; but troubles developed that put it out of the running. Just now another device, a swing gate that W. S. Stevenson is using in Philadelphia, is being tried out, but it is as yet too early to draw any conclusions.

It has not yet been definitely decided whether to shut off the flow to the interceptors completely, or nearly so, during storms, or whether to allow it to continue at a certain fixed maximum. As the writer sees it, shutting off completely has the advantage that the time of closing may be deferred and the time of opening advanced, without exceeding a certain average flow yet increasing the percentage of sewage in the total amount of liquor carried to the plant. On the other hand, if the interceptors shut completely, it is possible that certain storms will keep them closed long enough to curtail the flow unduly.

Committee Report Discusses Nine Double-Deck Freight Stations

Double-deck freight terminals with tracks on both levels have been advocated as a means of economic utilization of the high-valued property on which city terminals are located, or as a means of reducing the ground area required. No such arrangement seems to have been carried into effect in this country, although it has been employed in several cases in Europe. It was included in the designs for the immense freight station of the Pennsylvania Lines at Chicago; but when the location was changed, the plans were also changed. The structure now being built will have all the tracks at the lower, or basement, level, and the team driveways and platforms at the upper, or street, level.

In a paper written about two years ago by E. H. Lee, Vice President and Chief Engineer of the Chicago & Western Indiana R.R., it was estimated that an important increase in the capacity of city freighthouses, coupled with economy in investment and operation, would result from using the double-deck arrangement, thus giving much greater track and car capacity in a given area.

The subject was discussed in the report of the Committee on Yards and Terminals, presented at the 1917 annual meeting of the American Railway Engineering Association. Nine such stations are described briefly, five of which have the tracks on the upper level, while the others have them at the lower level. The cost of handling freight is naturally somewhat higher in the double-deck stations, due to extra handling and elevator service. The time of handling may be longer, also. These items are offset by the greater working capacity of the station and may be reduced by the introduction of light motor trucks to handle trains of freighthouse trucks, a subject that is also touched upon in the report.

As to the cost of handling freight between teams and cars in single-deck and double-deck stations under comparable conditions, the accompanying figures are given. It is interesting to observe that both the minimum and the maximum costs per ton of freight handled are in double-deck stations: 19.8c. for the Wabash-Pittsburgh Ry. station at Pittsburgh, and 38.5 for the Chicago Great Western R.R. station at Minneapolis. The other figures are as follows:

	Cents per Ton of Freight	
	Single Deck	Double Deck
Central R.R. of New Jersey: Newark	34 3	38 0
Southern Ry.: Atlanta	24 9	26 8
Long Island R.R.: Brooklyn	26 0	28 6
Pennsylvania Lines: Pittsburgh	30 7	31 5
Soo Line: Minneapolis	34 3	38 0

Construct 85-Ton Steel Hopper Car

A steel car of 85 tons, or 2900 cu.ft. capacity, and having five hoppers instead of four has recently been constructed by the Pennsylvania R.R. The car has a length, coupled, of 50 ft. 4 in. and an extreme width of 10 ft. 2 in., while the inside dimensions are 46 ft. 6 in. by 9 ft. 4¾ in. The height above rail is 10 ft. 6 in., and the front wheelbase is 5 ft. 10 in. A heap capacity of 328 cu.ft. brings the total capacity to 3228 cu.ft. The light weight of the car is 60,000 pounds.

Leaking Lap-Welded Steel Pipe Repaired and Tested by Bulkheaded Sections in the Field

Faulty Welds Made Tight by Heavy Riveted Butt-Straps—Special Rig Designed To Hold Large Riveting Gun Against Pipe

By CHARLES A. LEE

Assistant Engineer, British Columbia Electric Railway Company, Vancouver, B. C.

THE enlargement of the Jordan River hydro-electric plant of the Vancouver Island Power Co., Ltd., located about 45 miles west of Victoria on Vancouver Island, B. C., was completed in 1914 by the addition of a 13,000-hp. waterwheel-driven generator unit operating under a static head of 1145 ft. The pipe line supplying water for this unit is 9290 ft. long, varying in diameter from 48 in. at the bottom to 54 in. at the top. The lower 6781 ft. of this line is a lap-welded steel pipe manufactured by a well-known German firm. The uniform diameter of the pipe is 48 in., and the thickness varies from 1⅛ in. at the bottom to ½ in. at the top. A standard length is made up of two 15-ft. sections welded together to make a length of 30 ft. There are also two longitudinal welds diametrically opposite. The field joints are spherical bump joints, single or double riveted, depending on the thickness of the plate.

The specials or bends, of which there are 27 in the line, are shorter than the standard sections, but are made up in the same manner with the angle from 6 to 8 in. to one side of the circumferential weld. The maximum bend is 17½ degrees.

Circumferential Welds Leak

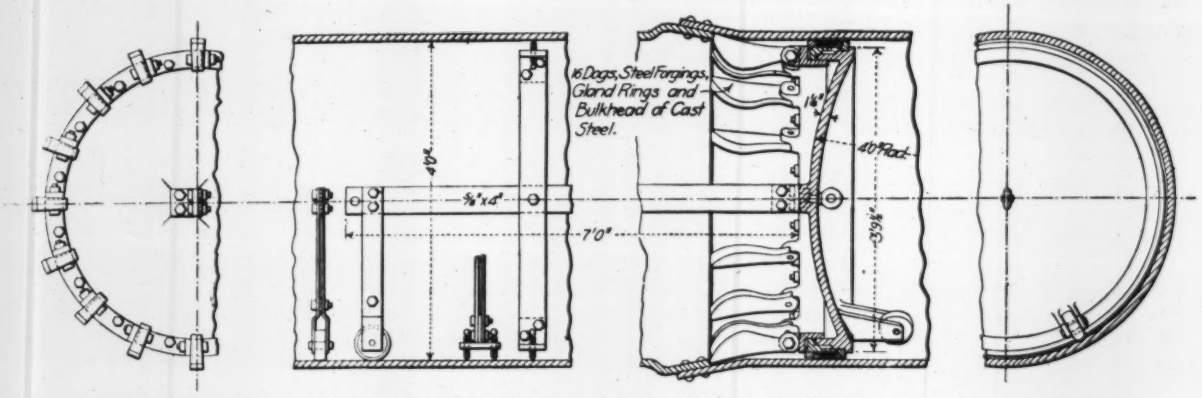
On filling the pipe for the first time several leaks developed in the circumferential welded joints of the heavier pipes near the power house, when the pressure was only a small fraction of the static head to which the pipes would finally be subjected. These leaks were repaired by riveting heavy butt-straps around the pipe at the faulty welds, but on account of the possibility of other leaks developing and damaging the power house or the other pipe lines, it was decided not to fill the pipe until it had been tested and made safe against further failures.

All the pipe sections had previously been tested at the pipe factory by subjecting them to a test pressure at least 50% in excess of the static head under which they would operate. It was thought, however, that the pipes might have been injured in transportation or that the shop tests had failed to subject the circumferential welds to stresses equal to those produced by filling the pipe after erection.

Pipe Tested in Field

It was planned to test the pipe in comparatively short sections, so that in case of failure the amount of water in the section under test would not be sufficient to do any damage. To make these tests, a bulkhead was designed to fit in the pipe at the upper end of the section under test and to confine the water between that point and closed gates at the lower end of the pipe.

The bulkhead was made up of a dished steel casting about 2½ in. less in diameter than the internal diameter of the pipe. The circumference of this casting formed the base of a packing gland built up of steel rings that confined the packing. The packing consisted of two rings of 1-in. square hard steam packing, one on either side of a ring of rubber packing 1 in. thick and 2 in. wide, as shown in the drawing.



BULKHEAD FOR FIELD TESTS OF PIPE WAS A DISHED STEEL CASTING, MOUNTED ON ROLLERS

The back steel ring of the gland was provided with 16 forged-steel dogs, which held the ring from moving up the pipe, the ends of the dogs resting against the end of the next section of pipe at a riveted joint. The pressure of the water against the bulkhead compressed the packing by forcing the bulkhead or disk into the back ring of the gland, which in turn was held securely in place by the dogs, thus making a water-tight joint. The whole contrivance was mounted on rollers to enable it to be moved along the pipe.

The pipe line was cut at the upper end of the welded portion and the bulkhead lowered by means of a light wire rope to the upper end of the section to be tested first. Some trouble was experienced at first in setting up the bulkhead in the pipe, but later the pipe crew were able to make a tight joint.

LEAKS IN LINE WERE REPAIRED BY RIVETING BUTT-STRAPS AROUND PIPE AT FAULTY WELDS

The pipe was filled to the bulkhead through a bypass from one of the existing lines, and the pressure was raised to the required test pressure by means of a large hand-operated boiler test pump. The bulkhead was provided with an air valve to exhaust all air from the pipe and make certain that the space was entirely filled with water. A pressure gage was attached to the pipe and in each test the pressure was raised by means of the pump or to 35% in excess of the pressure due to the static head. This pressure was recorded at the lower end of the section under test and was maintained for 15 min. Before making the excess-pressure test, each section was tested under static head by hammering along the welds with 3-lb. hammers.

Faulty Welds Repaired by Butt-Straps

Other leaks developed during the tests, all but one of which were in circumferential welds. These were not of a serious character, and all of them were repaired by riveting butt-straps around the pipe at the faulty welds. Sections were cut from several of the broken welds, and in each case the weld was found to be of very poor quality, the metal being oxidized; in many instances the actual area of the welded metal was less than half the area of the plate.

Only one failure occurred in the longitudinal welds; and although this break was of a serious nature, no great damage was done. This failure occurred in pipe 1 in. thick during a test when the pressure at the point of rupture was 497 lb. per sq.in. The split in the pipe was about 7 ft. long, following the weld for about 3 ft. and then tearing off at an angle across the plate. An examination of the weld at the point of failure showed it to be of very poor quality. This break was repaired by cutting out that section of the pipe and replacing it with a heavy riveted section.

So far as the writer has been able to learn, this is the first time a large high-pressure pipe line has been tested in sections in the field. In this case the results do not appear to justify the expense of the test, but it does not seem fair to condemn such field testing on account of the failure of these tests to disclose defects in the Jordan River pipe.

After the completion of the tests, the pipe was put in service and gave no trouble for nearly a year, when, during a period of zero weather, two more circumferential welds failed. The fact that the pipe is all laid in trench and is covered for its full length makes it difficult to understand why it should be seriously affected by temperature, but this may be a possible explanation of these two failures. The water in the pipe is always at a low temperature, which should keep the pipe comparatively free from temperature stresses.

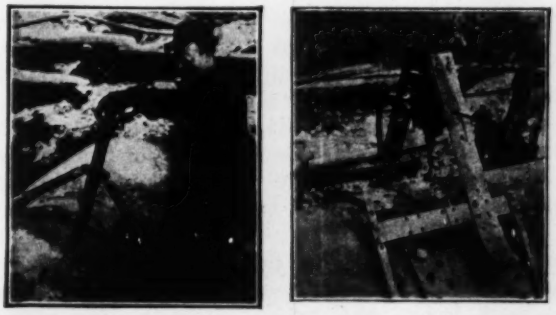
Welds Reinforced

Before putting the pipe in service again, it was decided to reinforce all the circumferential welds and thus avoid any further shutdowns. The reinforcement of the circumferential welds in the straight pipe sections consisted of butt-straps made up in two halves with scarfed lap joints. The straps were delivered on the job complete, with all rivet holes drilled, the edges bevel-planed for calking, and bent to the true circle of the pipe. The welds were first carefully located, and the straps were then securely clamped to the pipe over the weld by means of steel bands drawn up by bolts. High-speed air drills were used to drill the rivet holes in the pipe plate, the straps serving as templets. The rivets were driven from the outside by air riveting hammers of the largest size, having 9-in. stroke, and the calking was also done by air-driven tools.

The butt-straps were made of boiler steel of the same thickness as the pipe plate they covered. Up to and including the pipe $\frac{3}{4}$ in. thick, the straps were 18 in. wide and double riveted with 1-in. rivets. The $\frac{5}{8}$-in. and $\frac{1}{2}$-in. straps were 12 in. in width and single riveted, 1-in. rivets being used in the $\frac{5}{8}$-in. straps and $\frac{7}{8}$-in. rivets in the $\frac{1}{2}$-in. straps.

For drilling the first few holes for bolting, or tacking the straps to the pipe, the drilling rig consisted of a light channel frame secured to the pipe by flat steel bands passing completely around it. This rig was free to move around the pipe, and the drill could be set up over any ring of rivet holes. The remaining holes were drilled by a special rig in which the drilling machine was securely mounted. This frame was also free to move around the pipe, but a separate setting was required to drill each ring of holes.

The large riveting guns necessary to drive the 1-in. rivets were awkward to use on the bottom of the pipe and



RIGS FOR BORING AND HOLDING RIVETING GUNS

were very fatiguing to the operators. In order to make it possible for the riveters to drive more rivets per day, a rig was designed to hold the gun up to the pipe and relieve the operator of the most tiring part of his work. A clamp was secured to the barrel of the gun just above the lower exhaust parts. To each side of the clamp, a $\frac{3}{16}$-in. coil spring, 1½ in. in diameter and 10 in. long, was attached, and a light chain was passed around the pipe, connecting the two springs. By adjusting the length of the chain, the tension could be made sufficient to hold the gun tight to the pipe when in an upright position and still leave it free to be moved around the pipe or across the strap when tipped on its side. The springs also made it possible to "roll" the rivet head before coming off. This rig gave great satisfaction and is worthy of note.

Reinforcing the Bends

It was originally intended to reinforce the circumferential welds at the pipe bends by means of straps similar to those used on the straight pipe, but formed to fit over the angle in the pipe. On account of the imperfect forming of the bends, however, it was decided that it was impossible to make up these straps in any shop to fit the bends accurately, and it was certainly not advisable to lay them up hot over the bends in the field.

A different form of reinforcement was therefore designed for the bends, which consisted of four heavy cast-steel lugs riveted to the pipe on each side of the bend. The lugs were placed equidistant around the pipe and directly opposite to the lugs on the other side of the bend. Each pair of lugs was connected by a 3½-in. steel bolt threaded on both ends. The back of the hole in the lug casting, through which the bolts passed, was machined to a spherical form; and the washers on the bolts were turned to a true spherical surface to fit this seat. The lugs were all placed parallel to the center line of the pipe, and the angle was obtained by the automatic adjustment of the spherical washer in the seat. The steel lugs were riveted to the pipe over $\frac{3}{16}$-in. shims, or calking plates. The whole reinforced joint was incased in a heavy reinforced-concrete pier.

This form of reinforcement made, in effect, a flanged joint, the lugs acting as flanges and transmitting the longitudinal pipe stresses to the bolts. Only the lower nine bends were reinforced in this manner, as the upper eighteen bends in pipe under 1 in. thick were simply incased in heavy reinforced-concrete piers.

Work Nearly Completed in 4½ Months

On account of the difficulty in procuring the steel for the butt-straps, the fieldwork was not started until August, 1916. By the middle of December the work was all completed, with the exception of a few of the ½-in. butt-straps at the upper end of the line. Unfortunately, the winter peak load was so heavy that it was necessary to start up the generating unit that was supplied with water through this pipe line, necessitating the closing down of the fieldwork. The completion of the work is a matter of only a few weeks and will be carried out as soon as load and weather conditions permit.

The Pelton Water Wheel Co. installed the pipe under contract and made all the first repairs that were necessary. The bulkhead for testing the pipe was designed by W. A. Doble, chief engineer of the company, and the testing was done by the contractors, under the supervision of the writer. The fabrication of the straps and lugs was done by the Vancouver Engineering Works, of Vancouver, B. C., under contract. The contractor for the fieldwork was the Victoria Machinery Depot, of Victoria, B. C., which firm was responsible for the design of the special tools used.

The experience with this particular pipe has been unfortunate, but it would be very unwise and unfair to condemn lap-welded steel pipe on the strength of this experience. It is well known that many important high-head power developments are successfully using lap-welded pipe. It is also admitted that welded pipe has the advantage over riveted pipe in both first cost and hydraulic qualities. The methods of manufacture have been greatly improved in recent years, and there appears to be no reason to doubt the reliability of carefully made lap-welded pipe.

In conclusion, the writer wishes to state that this article has been written, not to call attention to the failure of pipe of lap-welded construction, but to give an account of the methods of testing and repairing this particular pipe.

Tests Indicate Strength of Tension-Rivet Connections

Results Given for Specimens Tested in the Laboratory of the Polytechnic Institute of Brooklyn

By C. R. HILL

Assistant Engineer, Office of Engineer of Structures, New York Central Railroad Company, New York City

A great deal has been said of late both for and against (mostly against) the practice of using rivets in tension in the design of structural connections. Prevailing practice is no doubt against the use of rivets in tension, but there appear to be very few (if any) data to warrant a complete prohibition of tension rivets.

Eight Tests of Tension Connections

Eight specimens of riveted joints were recently tested in the laboratory of the Polytechnic Institute of Brooklyn, and an effort was made to gain some idea as to the strength of rivets in tension in a particular type of connection. It is hoped that the results of these tests will throw some light on the problem in general and at the same time furnish some additional data to engineers who resort to the use of rivets in tension, when such a connection might appear unavoidable or might eliminate an expensive and cumbersome detail.

All the specimens were tested in a 100,000-lb. Riehlé testing machine, on which the load was applied at a speed of 0.15 in. per min. The scope and final results of the tests are fully set forth in the accompanying figures and tables. Fig. 2 gives complete structural details of each specimen. The final results of the tests are tabulated in Table I. Photographs of typical test specimens, showing the manner in which failure took place, are given in Fig. 1.

The results of some German tests on riveted connections, reported in *Der Eisenbau*, 1912, are tabulated in Table II. The resemblance between the results tabulated in Tables I and II should be noticed.

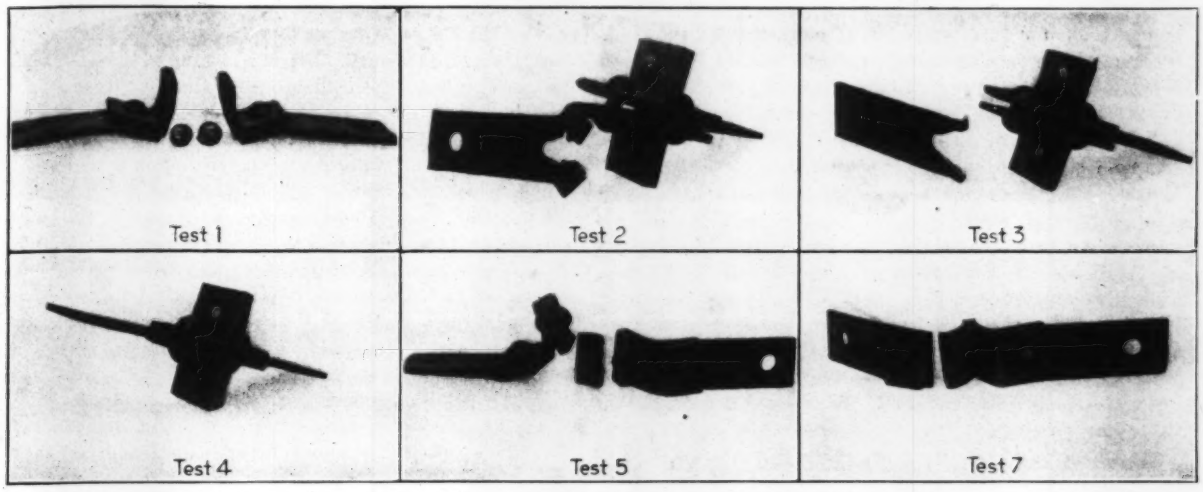


FIG. 1. SIX SPECIMENS FROM THE BROOKLYN TESTS AFTER FAILURE

The manner in which the rivets were loaded in these tests appears to be fairly representative of actual conditions of loading to which rivets in tension are subjected—that is, a direct pull together with an accompanying bending stress.

It was the common practice years ago for bridge companies and railroad companies to design railroad and highway bridge floors that were supported only by rivets in tension. A bridge that typifies this condition was located on the main line of the New York Central R.R., over the Erie Canal, at Newark, N. Y. This bridge was built in 1863 and replaced in 1901. It was a 154-ft. double-track span of three trusses, which had a panel length of 6 ft. 8½ in. Trusses were spaced 16 ft. between centers. The floor system consisted of transverse 9-in. 30-lb. (old style) I-beams spaced about 27 in. on centers. These transverse I-beams were suspended from the lower chords of the trusses by 1-in. rivets, in tension, through the horizontal legs of the chord angles and the top flanges of the I-beams. Assuming a reasonable distribution of the loads over the transverse I-beams, the computed stress on the rivets in tension was about 6000 lb. per sq.in., with no allowance for impact. Such a unit stress evidently gave satisfactory results in this old structure.

While not directly advocating the unrestricted use of rivets in tension, the writer believes, and the experiments and facts set forth in this article tend to prove, that in apparently unavoidable cases or where costly and cumbersome details might be avoided *rivets in tension may be resorted to with safety.*

TABLE I. TESTS ON RIVETS IN TENSION AT POLYTECHNIC INSTITUTE OF BROOKLYN, 1915

Specimen No.	Maximum Total Load Lb.	Average Unit Stress* on Rivets in Tension Lb. per Sq. In.	Where Failure Occurred	How Rivets Were Driven	Notes
1	19,000	43,000	In shank of rivet A	Machine	
2	33,000	38,300	At end of flat	Machine	No indication of rivets failing
3	40,000†	33,400	At end of flat	Machine	No indication of rivets failing
4	34,500†	28,700	In shank of rivet A	Pneumatic hammer	Rivets in tension were driven last; and because of size of angle, a good rivet was hardly possible
5	31,000	35,200	Angle A‡ failed at fillet	Machine	No indication of rivets in tension failing
6	17,000	38,600	In shank of rivet A	Machine	Rivet had small head
7	21,000	47,600	Angle A failed at fillet	Machine	No indication of rivets failing in tension
8	20,500	46,500	Angle A failed at fillet	Machine	No indication of rivets failing in tension

* Bending neglected.
† All rivets ⅞ in., except those used in Nos. 3 and 4, which were ¾ in.
‡ Load was further applied to this specimen until angle B failed at points Y and Z simultaneously at 19,000 lb., 43,000 lb. per sq.in. on the rivet.

TABLE II. TESTS ON RIVETED CONNECTIONS REPORTED IN "DER EISENBAU," 1912

Specimen	Maximum Total Load, Lb.	Average Unit Stress on Rivets in Tension, Lb. per Sq.In.	Where Failure Occurred
Specimen without packing plates....	139,113	43,000	In angle
Specimen with packing plates.....	141,098	43,800	In rivet shank

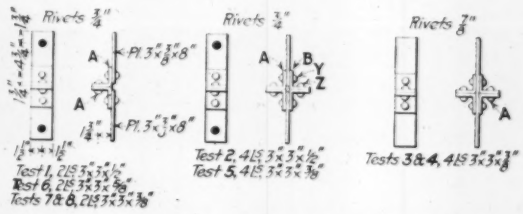


FIG. 2. TEST PIECES FOR TENSION-RIVET CONNECTIONS

This conclusion, however, is based on the assumption that a moderate unit stress is employed and first-class inspection insisted upon to insure that the rivets are properly heated and driven and tested for good heads after cooling. The following observations may be gathered from the tests:

In designing riveted joints in which rivets are to be used in tension, the strength of the connecting material should be sufficient to permit no undue bending stress on the rivet shank. The following table has been given careful study by the writer, and it is believed to be in conformity with safe practice:

Minimum Thickness of Connecting Angles, In.	Diameter of Rivets, In.
7/16	5/8
9/16	3/4
11/16	7/8

The strength of the head, in the case of every specimen selected for these tests, was equal to that of the shank. However, the attainment of this in practice will be de-

pendent upon several conditions, mainly the following: Sufficient material must be provided in the rivet head to conform at least to present practice, the rivets must be driven fairly in the hole, and the rivet head must not be hammered until it is "black and blue"; furthermore, the rivet steel used must not contain an excess of phosphorus, and it should not be a coarse-grained, dark-colored grade of steel.

All the specimens used in these tests were donated by H. S. Richmond, Structural Engineer for Gibbs & Hill, Consulting Engineers, New York City, and F. H. Brinton, Chief Shop and Mill Inspector for the New York Central R.R. Thanks are due to Prof. C. W. Hudson, of the Polytechnic Institute of Brooklyn, for the use of the testing machine, and to E. W. Squire, Instructor in Civil Engineering, for his assistance in the experiments.

To Secure Good Concrete Floors Follow These Suggestions

Selection of Aggregate Important—Satisfactory Patching Possible—Protection from Destructive Agents by Special Treatment

By W. P. ANDERSON
President, Ferro-Concrete Construction Company, Cincinnati

In laying a concrete floor the first consideration should be the selection of a proper aggregate. If the floor is to be subjected to heavy wear, a hard aggregate, such as crushed granite, traprock or flint pebbles, should be adopted, but for light traffic it is not necessary to go to extra expense in obtaining them. Sometimes sand contains a large percentage of limestone, which, of course, does not wear nearly as well as harder stone. The presence of limestone is indicated by the effervescence resulting from treatment with dilute hydrochloric acid. A simple test for the hardness of the aggregate is to determine whether or not it will scratch glass. Though some aggregates that do not scratch glass may be satisfactory, a sample that is hard enough to do so is certain to possess adequate wearing qualities. Where chemicals are likely to come in contact with the floor, select such aggregate as is least affected by them.

Satisfactory Wearing Surface Is Possible

In putting down cement floors satisfactory results can be obtained either by using a top dressing or by finishing the structural concrete itself. In the first case, use a mixture of 1 part portland cement and 2 parts aggregate ranging in size from $\frac{1}{16}$ to $\frac{1}{2}$ in. While it is proper to use stone larger than $\frac{1}{2}$ in., it is often necessary, where this is done, to make the finish thicker than would otherwise be required. Where a coarse grade of good sand can be obtained, a good mixture is 1 part cement, 1 part coarse sand and 1 part pebbles or crushed stone ranging from $\frac{1}{8}$ to $\frac{1}{2}$ in. or even larger. A satisfactory finish can be obtained by omitting the sand, but enough extra cement should be used to make the mortar work properly. Fine sand should always be avoided.

When it is known that a finish is to be added before the base has hardened, the base should be brushed with a stiff street-cleaning brush as soon as it is hard enough to walk on. This will remove all scum or laitance.

Too thick a wearing surface may crack if applied to a base already hardened. A $\frac{1}{2}$-in. finish is suitable, provided the inequalities of the floors will allow a finish as thin as this, but in any case avoid a thickness in excess of 1 in. The concrete base should be thoroughly cleaned with water, and all dirt, grease, paint, etc., should be removed. Then, while still wet, a cement grout should be applied. The mortar for the wearing surface should be thoroughly mixed, kept as dry as can be conveniently worked and should be placed before the grout has dried. After being struck off and compacted, it should not be floated until it has sufficiently hardened. Trowel the surface as little as possible; excessive working tends to bring laitance to the surface. It is better to sacrifice a little in the appearance if a hard surface is desired.

If the mortar is too wet, the finisher should not be allowed to add dry cement to take up the excess water. A 1:2 mortar thoroughly mixed should be used, and great care should be taken to work this drier material into the finish. A dry mixture consisting of 1 part metallic hardener and 1 part cement, by weight, thoroughly mixed, may be scattered over the surface after the first floating. This should be worked into the surface during the second floating, care being taken to keep the floor level and the material evenly distributed. It is generally unnecessary to use an iron hardener to obtain a good floor finish. With a pebble aggregate, 10 to 20 lb. of hardener for every 100 sq.ft. of surface gives satisfactory results. More will probably be found advisable with finer-sized aggregate.

Prevent Floor Injury While Setting

The floor should be kept moist for at least 5 days after the surface has hardened and no heavy trucking should be allowed for 10 or 15 days. A good method of keeping the floor moist is to cover it with building paper, over which a thin layer of sand should be placed and kept moist. When this is done, building operations can continue over the floor without damaging it, and proper curing will be assured. This is one of the most important points though often neglected.

A floor in the factory of the William Koehl Co., Cincinnati, was finished with a mixture of 1 part cement, 1 part coarse bank sand (containing approximately 50% limestone) and 1 part Ohio River pebbles of the size used on tar and gravel roofs or for granite paving. These pebbles are mostly flint, will scratch glass and carry less than 5% limestone. The finish was generally laid the day after the structural concrete was placed. Several months after the floors had been finished, a coat of kettle-boiled linseed oil was applied. They have been in use for over a year with no signs of wear, although heavy loads of paper are trucked over them on small-wheeled trucks.

Finish Structural Concrete Where Possible

On structural-concrete floors it is possible to get an excellent finish directly on the 1:2:4 concrete, provided a hard aggregate is used. This is probably the cheapest method of getting a satisfactory floor—if the weather conditions are such that the floor will not be damaged by rain or frost while being laid. The leveling up of the concrete is most important and is best done by gaging to strips nailed to the floor panels. A few low places, easily seen after the water comes to the top, are apt to occur; these should be leveled up with dry 1:2 mortar thoroughly worked into the concrete.

In summer months the concrete is generally set enough to allow floating two hours after placing. This floating should get all the stone down from the surface, leaving it smooth for a coating of metallic hardener, which it is ready to receive about an hour after the first floating. This coating is a dry mixture containing 1 part metallic hardener, 1 part sand and 2 parts portland cement, placed evenly, 30 lb. per 25 sq.ft. When ready to receive the coating, the floor is blocked off by laying a steel rod, bent to form a 5-ft. square, in the wet concrete, leaving a mark easily seen. Immediately after the coating is spread, the finishers should work the surface with a wooden float. It is then left until sufficiently hard for the last floating and the final troweling. In finishing, the marks left by the square are obliterated. On flat-slab construction the concreting is not slowed up at all by using this method.

Attack by Acids Can Be Prevented

A floor that is to be used for trucking should never be blocked off by joints, which collect dirt, are unnecessary and are chipped by truck wheels. This applies no matter what method of finishing is used, and to floors laid on the ground as well. It is sometimes advisable to reinforce floors laid on the ground, if there is danger of cracking due to settlement.

Cement floors, even when properly laid, may become damaged by injurious substances, such as acids, strong alkali, animal and vegetable oils, and fruit juices, sugar solutions, etc., containing weak acids that will act on the free lime in the cement to form compounds soluble in water. Moist coal has been known to injure floors, due possibly to the water forming a weak acid with the sulphur in the coal.

Several means can be used to prevent dusting and prevent or retard the injurious effects of acids. These methods consist of treating the floor with a liquid hardener that acts chemically on the free lime in the cement, by coating the floor with a paint or other substance or by a combination of the two. The liquid hardeners convert the free lime to a calcium compound insoluble in water, which fills the pores of the finish, thus hardening the surface and preventing dusting. This calcium compound may be less subject to attack by acids than the original free lime, and it forms a protection to the underlying material, which has not been changed.

Action of Chemical Hardener

It is necessary that a chemical hardener come in contact with the free lime in the cement. If the free lime in the finish has already been acted upon by acids, there may be none left for reaction with the liquid hardener. A simple test to determine whether sufficient free lime is present is to scrape the floor to remove all dirt, oil, etc., and put a drop of phenolphthalein on the clean cement finish. If free lime is present, the surface will change to a reddish color. There are on the market liquid hardeners that seem to assist a cement floor in resisting vegetable oils, fruit acids, sugar solutions, acetic, lactic and oxalic acids and weak solutions of hydrochloric or sulphuric acid, but I know of no hardeners that can protect against nitric or hydrofluoric acid. Where a cement floor is subjected to hydrofluoric acid, it should be coated with a thin film of paraffin, heated until it becomes a free-flowing liquid and poured in a thin film entirely over the floor, which should be as clean as possible and perfectly dry. It is well to heat the floor with a blow-torch or other means so it will not chill the paraffin. This provides simply a mechanical coating and will of course wear off if the floor is subjected to trucking or other hard uses.

Sometimes a floor will become slippery, and this can be partly remedied by treating with a dilute solution of hydrochloric acid. Use about 1 part acid to 3 parts water; and after the acid has acted sufficiently, wash thoroughly with water. Floors on which horses, cattle, sheep, etc., may stand should always be left rough, but this is sometimes neglected in laying the floors, and it becomes necessary to roughen them later. Acid will not produce a rough enough surface. The best method is to chip the surface with a tool shaped like a double-edged axe. In roughening a surface in this way it is not necessary to remove the entire surface, but simply to make lines about 2 in. apart in both directions.

Where floors are apt to be damaged on account of existing cracks, these cracks should be repaired at once by filling them with some elastic compound capable of expanding and contracting, which will not get too soft in summer or become brittle and chip in the winter. The best material for this is perhaps a mastic composed of asbestos fiber and elaterite.

Satisfactory Patching Demands Special Care

Sometimes a floor becomes so badly worn or eaten by acids that it is necessary to patch a portion of it. In such cases, roughen the surface with a pick to the depth of ¾ to 1 in., making the edges vertical. Clean all surfaces thoroughly and keep the depression filled with water overnight. Just before adding the finish, mop up the excess water, but leave the surface thoroughly wet, thus insuring a good bond between the old and the new concrete. A mixture consisting of 2 parts cement and 1 part of sand, with enough water to make a liquid grout, should be dumped in the depression and brushed in. The layer of grout should be as thin as possible and should thoroughly cover all the exposed surface.

Before the grout layer dries, the finish should be put down in accordance with the directions given for floors placed on a base already set. After the patch has been placed, treat the adjacent floor with a liquid hardener, provided the surface can be put in condition to make the hardener effective. This will harden the old surface so that, when wheeling from the patch to the old surface, the tendency to break it where the track rolls off the new patch will be lessened or entirely obviated. Such a patch at the Heekin Can Co., Cincinnati, is subjected to very heavy trucking with truck loads of 2500 lb. The cheapest patch consisted of 1 part portland cement, 1 part bank sand (said to contain 40 to 60% limestone) and 1 part flint river pebbles. So far, after four months, this seems to give as satisfactory results as any.

In some instances a strip of mastic material has been placed over the joint between the old and the new surface. This material is similar to that used for filling cracks and comes as a paste that can be thinned with benzine and can be put on quite thin. The strip is from 4 to 6 in. wide and is used to prevent the floor from chipping at the joint, which sometimes occurs when trucking over it. The surface to which it is applied should be thoroughly dried before it is placed. This mastic will withstand most mineral acids, such as sulphuric, hydrochloric, nitric, etc., but will not withstand food or fruit acids or animal oils.

Bridge Caissons Sunk in River Where Tide Varies 33 Feet, Creating 15-Mile-an-Hour Current

Swift Ebb and Flow Which Washed 600-Pound Car Wheels About, Made Bridge Construction at Moncton, N. B., Difficult—Heavy Caissons Required

By C. H. HOLLINGSWORTH
Consulting and Construction Engineer, St. John, N. B.

A THIRTY-THREE-foot tide, accompanied by a 4-ft. bore and a 12- to 15-mile current that changed the contour of the bottom daily, introduced unusual difficulties into the work of sinking two caisson piers for a new bridge across the Petitcodiac River to connect Moncton and Coverdale, N. B. As it was impracticable even to weight the caissons sufficiently to hold them down on the bottom under the air pressure that would have been required at high tide, sinking could only be carried on during short periods of the day. The cableway had to be used for handling all materials, and a great deal of unusual work in connection with launching and sinking the caissons themselves was required.

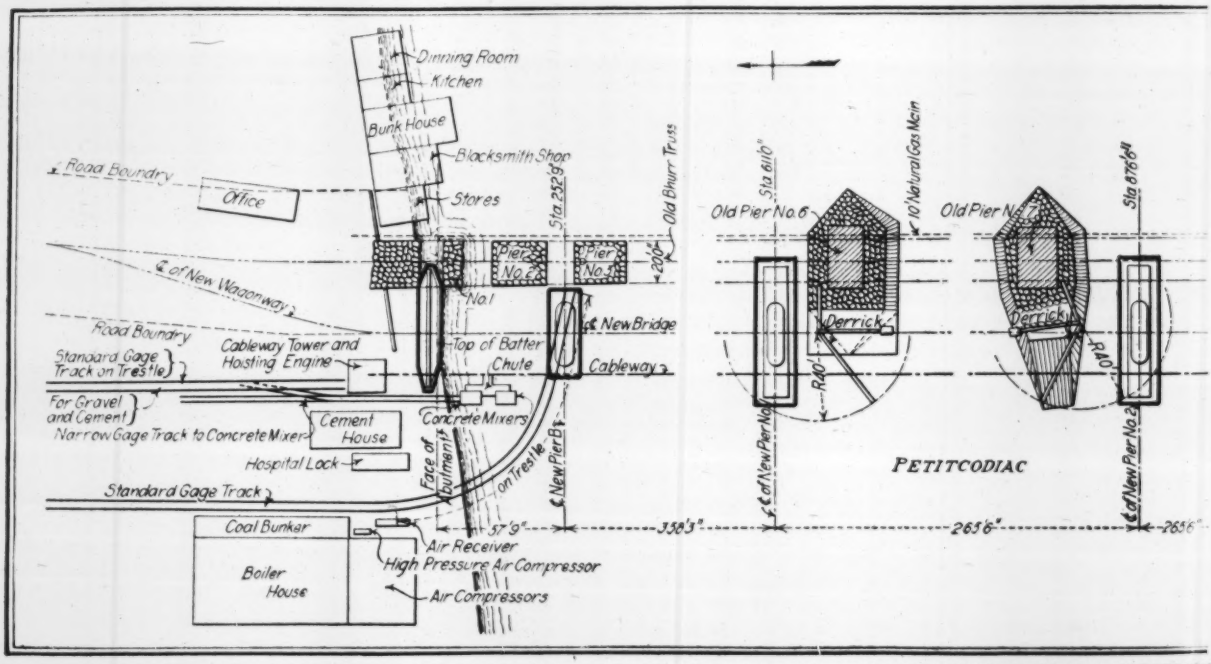
Old Bridge Settling

The structure that the new bridge will replace consists of wooden through-trusses resting on timber cribs filled with stone. It was built in 1872 and has been in poor condition for some time. The piers are still sinking, making it necessary every spring to jack up the spans, sometimes as much as 4 ft. The new highway bridge is a through-truss steel structure 1487 ft. long, with six spans. The abutment on the north bank at Moncton rests on piles, as does the pier next to it. The next two piers to the south, known as No. 1 and No. 2, rest on pneumatic caissons sunk to rock. Piers 3 and 4 rest on rock a few feet below low water and were built inside open cofferdams. The south abutment rests on rock near the surface.

Work on all of the substructure, except the pneumatic piers, was completed early in June, 1916. A cableway with 90-ft. towers and a span of 1591 ft. was used to convey all materials to the river work, construction at each site being carried on with derricks set on the upstream ends of the old bridge piers. While the remainder of the work was going forward, the caissons for piers 1 and 2 were constructed on the south shore.

Tide Variations Extreme

About 18 miles below the bridge the Petitcodiac River discharges into the Bay of Fundy, where the highest tides in the world, sometimes exceeding 50 ft., occur. At the bridge site there is a maximum difference of 33½ ft. between high and low water. The current, reversing four times in 24 hours, was measured with a ship's log and found to reach velocities as high as 15 miles per hour. Owing to the obstructions presented by the thirteen unusually large piers under the old bridge, the current varied every minute in direction and force, changing with startling suddenness, running directly across the river at some points and even swirling back against the main current.



RAIL DELIVERY OF ALL MATERIALS WAS AT NORTH BANK, BUT UNFAVORABLE SHORE CONDITIONS USE OF CABLEWAY TO

Twice every 24 hours at the start of the incoming tide a 5-ft. bore reaches the bridge site, traveling at high velocity and striking with great force all obstructions and any boats moored in its path. The time from the arrival of the bore to high tide is about 3 hours and 10 min. From high water to the next bore time is slightly over 9 hours, during the first 6 hours of which most of the tide runs out. On this account most of the sinking was carried out in two shifts a day, work stopping with the arrival of the bore at the bridge.

North Bank Too Soft for Launchways

Although all material was delivered on the north bank and the caissons were to be sunk close to that bank, this part of the river was soft mud for a depth of 30 ft. and offered no suitable place for constructing or launching them. As the south bank slopes gradually and consists of hard gravel and boulders, the timber was transported to that side and the caissons were built there. The launchways were located far enough upstream from the cableway for the caissons to clear it by about 30 ft. A stiff-leg derrick with a 50-ft. boom was set up to place the timber. In order to build both of these caissons at once and use the same launchways, they were set close together, one directly in front of the other and broadside to the river.

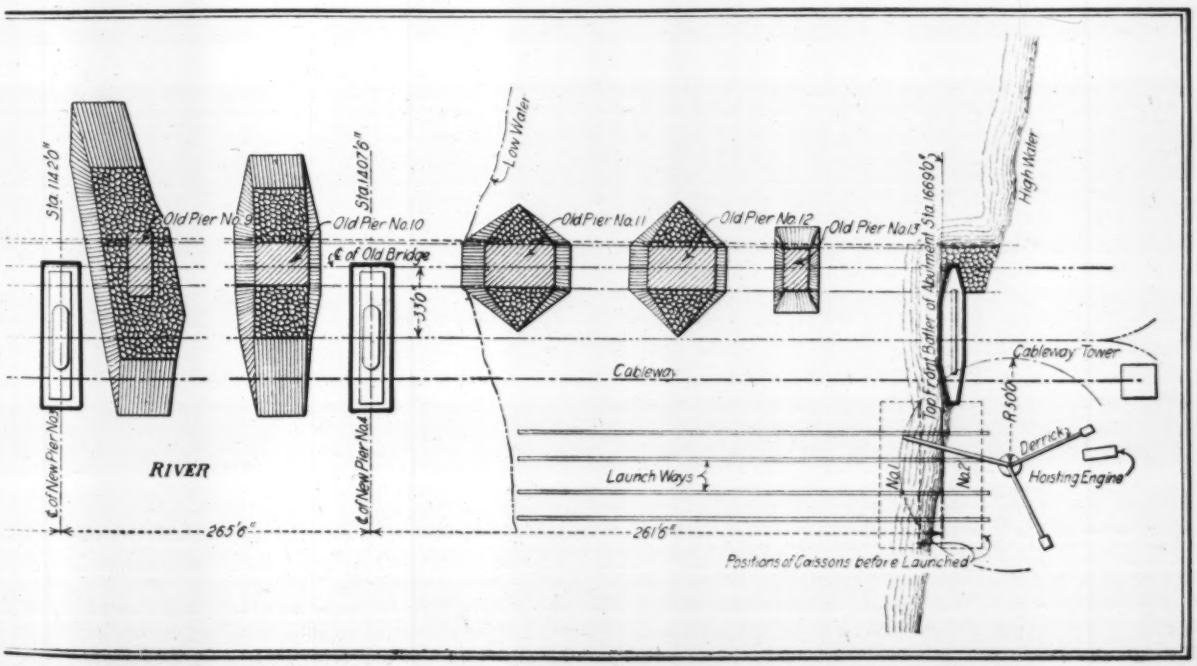
Hard pine and beech, both of which were found to weigh about 55 lb. per cu.ft., were used in the construction. The timber was delivered on the railroad siding at the north bank, unloaded by a derrick and run through a planer, surfacing all four sides. The edges of the sheeting were also beveled to make a calking seam. All the timber that was to be placed before launching was then run to the cableway on handcars and taken across the river, except for a small amount that was hauled across the old bridge by team. The cofferdam timber placed after the caissons were set was framed in courses laid on top of each other, being then taken apart and sent out to the piers by the cableway. After several cofferdam courses had been built up, the lower ones would be sent out for assembly in place, the upper course being retained as the bottom course for the next lot to be framed. In this way very close and solid work was made possible.

Caisson Construction Extremely Heavy

As indicated in the drawings, the caissons were of heavy and solid construction for work that required a maximum of only 25 lb. air pressure. The added stiffness, the liberal use of bolts and the thorough calking, however, demonstrated their value under unusually severe conditions. The walls and decks of the two working chambers, which were alike, were 24 in. thick, being made of two layers of 12 x 12-in. timbers. The timbers of the outside skin were laid seven courses high and calked on both sides. The timbers of the inside skin were placed vertically and bolted to the outside timbers. Three out of every four of these extended only to the under side of the deck, while every fourth timber ran up through the deck. These timbers were calked on the inside.

Both courses of 12 x 12-in. deck timbers were laid across the caisson, the first course being only long enough to rest on the inside skin of the working chamber and butt against the outside skin. The upper course consisted of timbers 2 ft. longer, extending clear to the outside of the walls. The bottom course was calked top and bottom, and a sheet of roofing felt with pitch joints was laid between the two deck courses. The upper course was also calked on top. Every timber was driftbolted to the next one in both courses and driftbolted down at the ends.

Inside the working chamber a 12 x 12-in. waling strip ran around the side walls directly beneath the deck to



FORCED CONSTRUCTION OF CAISSONS ON SOUTH BANK—GREAT TIDAL RANGE MADE NECESSARY REACH RIVER PIERS

support the ends of those short deck timbers that butted against the long vertical timbers of the inside skin. This strip was bolted through the side walls every 2 ft. and through the deck every 2 ft. to a second waling strip, the bottom of which was 18 in. above the top of the deck. Inside the working chamber, 2 ft. above the cutting edge, were six 12 x 12-in. braces across each caisson, flanked by 1½-in. rods with turnbuckles running through the walls on both sides. The walls and roof of the working chamber were sheathed with 3-in. plank, which was calked and pitched. The 3-in. sheeting outside the caissons extended high enough to be at the level of the river bed when the caissons reached rock.

The walls of the cofferdams above the decks were formed of one thickness of 12 x 12-in. timber surfaced and calked on the outside. The vertical timbers extending through the deck from the working chamber were carried to the top of the cofferdam and bolted to each course. Also, 12 x 12-in. ties, spaced 12 ft. apart horizontally and in layers 2 to 5 ft. apart vertically, were dovetailed into the side-wall timbers of the cofferdam and also bolted to the verticals against which they came. A similar longitudinal tie in each layer of bracing was dovetailed into the end walls and bolted to each cross-timber. Two solid 12-in. timber bulkheads divided each cofferdam into three compartments.

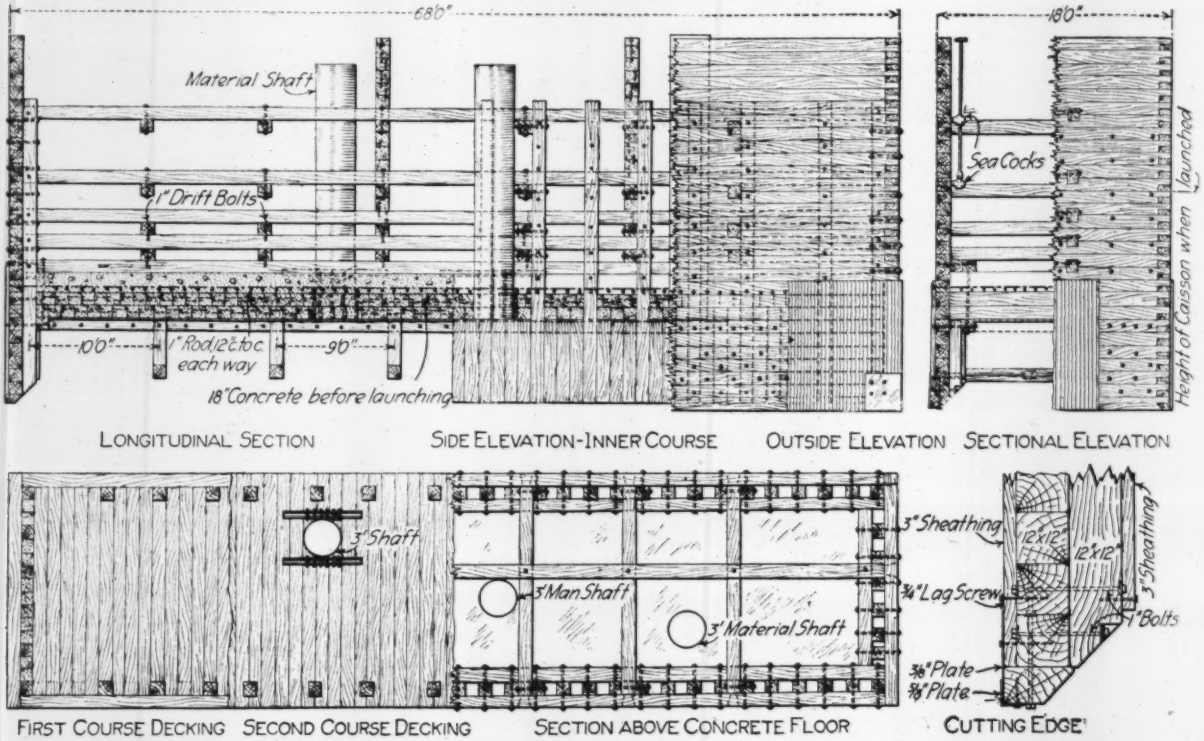
Deck Covered with Reinforced-Concrete Slab

As the deck would have to stand a great weight of green concrete before sinking was begun, it was reinforced by pouring an 18-in. slab of concrete on it before launching. This slab was reinforced in both directions by ⅞-in. round bars 12 in. apart, which ran clear through the side and end walls. The longitudinal bars were spliced with sleeve nuts with right and left threads. This concrete came to the bottom of the first course of wales above the deck.

Above the deck each of the three pockets of the cofferdam had four 4-in. sea cocks for flooding. For anchoring the caissons, four 1¼-in. ring bolts, two just below the deck and two about 14 ft. above the cutting edge, were placed in each end. A bridle was made up at each end with short sections of 1¼-in. cable leading to each of the four eye-bolts and coming together at one large shackle.

Heavy Anchor Lines Required

The caisson as launched was 18 ft. 8 in. high. In order to have it above low tide when sunk, the site being 24 ft. deep at the lowest point, it was anchored near position while additional timber was placed. Each end



HEAVILY BOLTED CAISSONS HAD DOUBLE WALLS AND TWO-COURSE DECKS WITH ROOFING FELT BETWEEN LAYERS

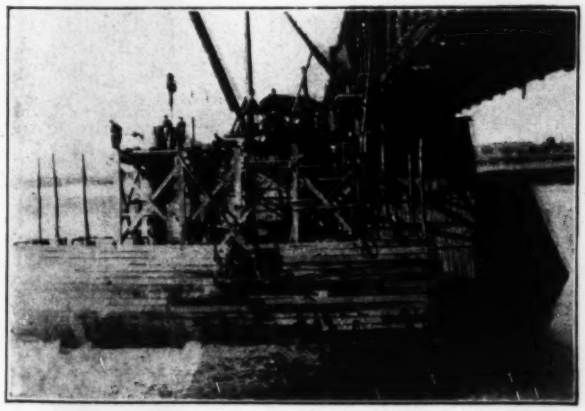
of the caisson was anchored with two 1¼-in. steel cables. On the upstream end one cable was attached to a stone-filled log crib sunk in the center of the river and the other to a deadman on the north shore. To a socket on the end of each of these cables next the caisson was shackled a double steel block. Another block was shackled to the caisson bridle, and through these three blocks were rove five parts of ⅝-in. wire rope with the end belayed around the vertical timbers on the caisson so that it could be slacked out. The downstream end was anchored in the same way with one cable leading to a log crib in the river and a second to the lower end of one of the old bridge piers. In addition to these cables four breast lines of 1½-in. manila rope rove through double blocks and leading to the old bridge piers on either side were used.

Anchored in this way the caisson remained in place through the first outgoing tide and through one incoming tide. On the second ebb tide one of the anchor cables parted, and the resulting strain on the second line broke it also. After that, the caisson easily went through all the other lines as it turned broadside and gained momentum. It finally grounded broadside to the current about 600 ft. below the bridge, near the north shore. The force of the current turned it partly on its side; and while arrangements were being made to raise it, each flood tide would set it upright and the next ebb tide would roll it on its side again. Meanwhile the current dug a deep hole and piled up a bar around it.

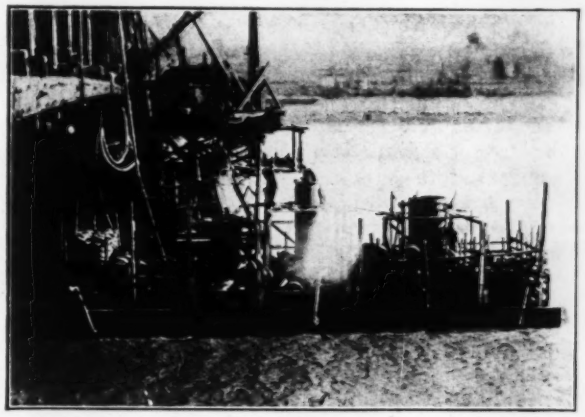
By running three cables to the old bridge and taking up the slack when the incoming tide righted the caisson, it was held upright and nearly level. Three courses of timber were added, and a scow was placed on each side of the caisson at low tide. Meanwhile a crib had been sunk downstream from it and two deadmen dug ashore. The caisson was then pumped out, lashed to the scows to prevent capsizing, and anchor cables were taken to the two deadmen and to the crib. Provision was made for slacking these lines on board the scows.

The bore comes in with great force, but one-half to one hour later comes a second rush more violent than the first. When this struck the caisson and scows, there was not enough water for the caisson to float over the bar formed around it by the current. As it was broadside to the tide, it was exposed to the full force of the current, which tilted it so as to snap the line from the river crib and one of those from the shore. However, the scows prevented the caisson from capsizing; and when the water was deep enough to float it out, it swung around and drifted toward the bridge.

Additional lines were run out, and the caisson was finally grounded about 400 ft. below the old bridge, close inshore. It was cleaned out and built up to 24 ft. in height. It was then moored in exact position against guide piles braced back to the old bridge pier, about 12 ft. downstream, and held until low tide. Concrete was then placed in the center pocket and the sea cocks opened, sinking it in place. The timber was carried several courses higher, and the pockets were pumped out one at a time and concreted. At about low-water level additional reinforcing consisting of 40-lb. rails running from end to end of the caisson was placed.



DERRICKS SET ON OLD PIERS RECEIVED CONCRETE FROM CABLEWAY



CAGE KEPT CURRENT FROM SWEEPING OFF CAR WHEELS

As the caisson landed with a list of 15 in. and a dip of 3 ft. toward the upstream end, one end overhanging a depression in the river bed for about 20 ft., concrete was only carried to 35 ft. above the shoe until the air was on and the bottom leveled up. The concrete was then carried to 38 ft. above the shoe, and two courses of granite were built.

Even with this weight about 600 tons additional ballast was required. No pig iron or other material of the kind could be bought or rented at any price, but it was possible to obtain large supplies of second-hand car wheels from the Intercolonial Railways, the general headquarters of which are at Moncton. These wheels, weighing 600 to 650 lb. each, are easier to handle than pig iron. They pack about as well and indeed are better in this respect than anything else except steel billets.

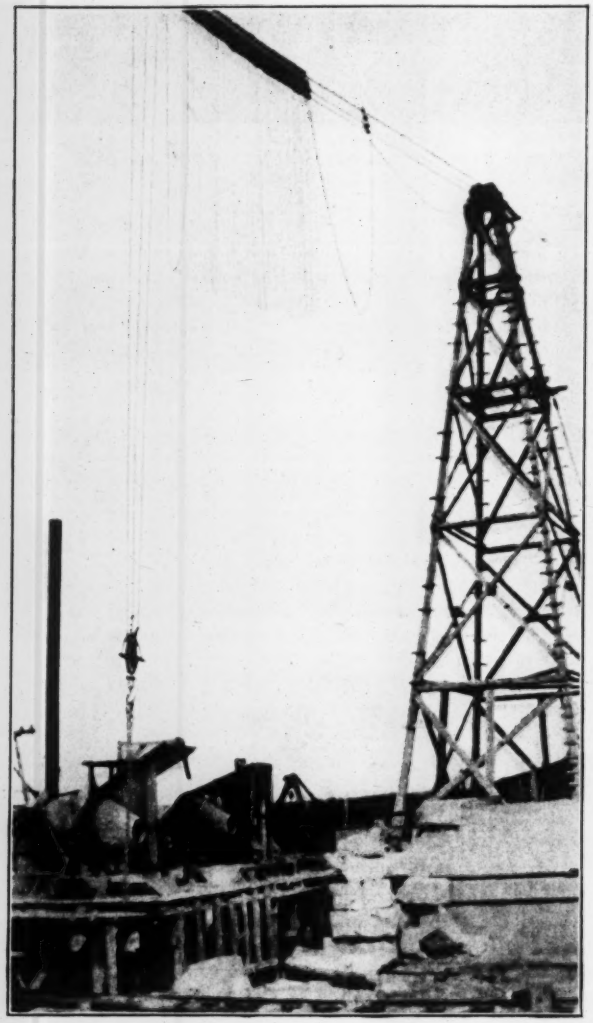
The wheels were delivered under the cableway in cars and sent out in slings of five each to the caisson. At the ends they were stacked on their sides, but elsewhere they were piled in promiscuously. To prevent the current from washing them overboard (for it will quickly do so, and the writer has seen it wash a 1½-ton granite block off a pier), a cage of rough round timber spiked together and tied with cables was built to a height of 16 ft. above the top of the cofferdam.

Tides Fill Working Chamber with Sand

The upstream material lock was served by a derrick with a 50-ft. boom placed on the old bridge pier. Although this derrick could also reach the lower material lock, a short boom mounted on the upstream side of the old bridge and equipped with a single block and swinging gear was used to handle material most of the time at the downstream lock. When air was placed on the first caisson, it was found that mud and silt had filled the working chamber within a foot of the roof under the downstream end and that about 25 ft. at the upper end was open to the river. For the first two or three shifts the mud was handled from the downstream end to the upstream, where it washed out under the shoe. To work 24 hours in the tides encountered would have required 2000 tons of weight at high tide. As the caisson weighed only 1000 tons when submerged and as 1000 tons additional weight would have increased its height to 67 ft., making a structure that could not have been handled in

safety on the shifting bottom, it was considered best to work only at low tide, using two shifts of men.

For about 6 hours previous to the arrival of the bore the tide is within 6 ft. of low water, and the shifts worked during this period, which occurred twice daily. As the time of the tide shifted ahead an hour each day, the gangs had to start an hour later every day. Air would be turned on about 6½ hours before bore time, the lock tenders being on hand and the electrician going down at once to place the lights. Two other men also went in



MIXERS DISCHARGED DIRECTLY UNDER CABLEWAY

to tend the blowpipes in case it was necessary to blow out any water.

After the first caisson had been sunk through 10 ft. of hard gravel and boulders, a layer of 5 or 6 ft. of silt was encountered, which softened when wet. On entering this material the cutting edge was partly cleared for a drop of about 10 in. When the air was taken off, however, the caisson settled about 18 in.; and before the next shift had come on, it had gone down more than 3 ft. When this shift started in, it was found that the working chamber was full to the roof. In order to get inside, men went down the material shafts in small buckets made from half an oil barrel. By using short-handled shovels room was worked out for the regular caisson buckets. It required several shifts before the gang could work to advantage, as silt washed in after every shift.

From this point down, there was continual trouble with sand filling in the working chamber. Also, this material was sticky and hard to shovel. It could not be worked with a blowpipe, as all the water would be drawn out, leaving it dry for 2 ft. around the suction, though soupy elsewhere. Rock was indicated by the borings at elevation plus 0.5; but at this point a 3-ft. seam of loose gravel was encountered, and it was found that the rock actually lay 6 ft. deeper. This gravel was so coarse that there was great difficulty in keeping air on, and silt came in freely. After the gravel was penetrated, the remaining distance through clay and shale rock to hard sandstone was made without difficulty. The caisson was lowered on wedges, leveled and the space between the shoe and the rock surface grouted, after which the entire bottom was concreted to a depth of 2 ft.

This procedure, which was followed with both caissons, obviated all trouble with silt washing in during the process of concreting the working chambers. This concreting was done in sections, using first the upstream and then the downstream material lock and finally the man lock, the usual small passageways being left to pack concrete tightly under most of the roof of the working chamber, and filled as the last operation before taking off air by dropping wet concrete down the shafts. The concrete was carried out to the caisson by the cableway and dumped into a hopper erected over the lock in use by the derrick.

Depth Shifts Eight Feet Between Tides

The problem of placing the second caisson was complicated by the fact that the depth at its proposed location changed with bewildering celerity. On one low tide there would be but 8 ft. of water at the site, while soundings on the next low tide would show 16 ft. As the caisson drew 13 ft. and had to be placed at low tide, these changes were serious. Finally, however, the depth of water remained nearly stationary for several days, and this caisson was launched and placed in the same manner as the first had been.

One new 2-in. steel cable leading to a crib upstream from the caisson and two 1¼-in. cables, all three equipped with double steel blocks rove with ¾-in. wire rope, were attached to the upstream end of this caisson to slack it down into place. The large cable was attached to the bridle, and the smaller ropes to the cross-timbers inside the cofferdam. No downstream anchors were provided, this caisson being built to a height of 16 ft. 8 in., carrying it above water at low tide, so that it could be slacked into place and sunk at once. Shortly before low tide it was accurately placed, allowed to ground and water admitted to all three pockets. At each low tide one pocket would be pumped out and concrete deposited until the concrete had been carried up to water level, when the cofferdam was built up to finished height and the concrete work also completed.

When air was put on this caisson, it was found to be resting on a mass of boulders at each end with the middle about 2 ft. above the river bottom for a distance of more than 30 ft. There was no silt in it, as the tide swept

through it at 10 miles per hour, it being almost impossible at first to stand up in the current. This was soon remedied, however, with clay sacks. The caisson was leveled up and sunk 6 ft. through gravel containing many large boulders running up to 2 cu.yd. in size. The material below this depth contained clay; but the larger boulders continued all the way down to rock, which was found at a depth of 20 ft. below low water. Almost all the boulders in the first caisson were small enough to be taken out through the lock; but a great deal of blasting had to be done in the second, which made progress much slower.

The ground being more open in the second caisson, it was more difficult to maintain the air pressure, and both compressors were run to full capacity—about 2500 cu.ft. per min. Throughout the sinking of this caisson the method developed toward the last on the first caisson—keeping on the air pressure between shifts—was resorted to. This was done by holding whatever the working pressure had been and allowing the water to back in as the tide rose, instead of blowing off the air at the end of the shift. In this way much less silt was washed into the caisson. About 550 tons of car wheels was required for weight on the second caisson. It was considerably more strained than even the first caisson, on account of its bad position on the bottom, but nevertheless leaked a very small amount.

Gangs Doubled Up on Second Caisson

On the first caisson about 25 men per shift were worked, 20 of whom were inside the caisson. In the material encountered with the second caisson, however, a gang of this size could not accomplish much in a short shift. On this account the gangs would double up on two successive shifts, both crews working both tides. On the next day only single gangs would work for two shifts, after which the crews would be doubled up again.

The compressor plant, located on the Moncton shore, consisted of two straight-line Ingersoll-Rand compressors of about 1250 cu.ft. capacity each, supplied with steam by five boilers aggregating 300 hp. A 4-ft. diameter receiver 15 ft. long was used, from which two 4-in. air lines led out on the old bridge to the caissons. The concrete was mixed by two ½-yd. mixers, to which material was supplied by means of cable cars on an inclined trestle. The mixers discharged through a chute to buckets directly under the cableway.

Air was put on the first caisson on Aug. 6, and the concreting of the working chamber on the second was finished Nov. 10, last. The air pressure at starting was about 9 lb., while the highest pressure, reached on the first caisson, was 25 lb.

Personnel

The bridge is being constructed for the Provincial Government of New Brunswick under the supervision of A. R. Wetmore, chief engineer, Department of Public Works, with R. Malloy as resident engineer. The Engineers and Contractors, Ltd., of which E. R. Reid is president and E. M. Archibald engineer and manager, carried out the contract for the entire substructure. The writer, as consulting engineer on the design of the caissons, was in direct charge of the launching, placing and sinking and of the various other matters connected with the compressed-air work.

Investigate Condition of Concrete Tile in Alkali Country

Bureau of Standards and Other Bodies Give Conclusions Arrived at After Extensive Study

THE Bureau of Standards, in coöperation with the Reclamation Service, the Drainage Division of the Department of Agriculture and the Portland Cement Association, has for the last few years been investigating the behavior of concrete drain tile in the alkali regions of the arid West. The investigation covered the manufacture of many concrete blocks, and of 9000 cement drain tile of 20 different varieties, their shipment to various Government projects in the arid West where alkali water prevailed, also to fresh-water projects in Minnesota and Missouri, and their behavior under normal operating conditions. The first result of the investigation is published in Technologic Paper 95 of the United States Bureau of Standards, entitled "Durability of Cement Drain Tile and Concrete in Alkali Soil." The general results may be summarized as follows:

Concrete Must Be Dense

Concrete that is to be placed in alkali soil should be made of selected and tested material, so proportioned as to produce a dense concrete. As small an amount of mixing water should be used as will allow the mass to be placed properly. If these precautions are taken, the resistance to alkali action will be reduced. The following conclusions were drawn as to the use of concrete drain tile exposed to soils or waters containing alkali salts in quantities of 0.1% or greater: (1) The use of cement tile in soils containing alkali salts in large quantities is experimental. (2) Porous tile, because of the use of lean mixtures or relatively dry consistencies, are subject to disintegration. (3) Some dense tile are under certain conditions subject to surface disintegration. (4) Disintegration is manifested by physical disruption caused by the expansion resulting from crystallization of salts in the pores and by softening, resulting from chemical action of the solution with the constituents of the cement. (5) While the results obtained will not permit a definite statement as to relative effect of the various constituents of the salts, indications are that the greater the quantity of sulphate of magnesium present and the greater the total concentration of salts the greater will be the disintegrating effect. Rich tile made by the process commonly used, which allows removal of forms immediately after casting, are subject to disintegration when exposed to soils or waters containing 0.1% or more alkali salts similar in composition to those encountered in this investigation. (7) Hand-tamped tile of plaster consistency are not equal in quality to machine-made tiles of the same mixture and do not resist alkali action as well. (8) Steam-cured tile show no greater resistance to alkali action than tile that are cured by systematic sprinkling with water. (9) Tile made with sand-cement have less resistance to alkali action than tile made with portland cement in the same proportion. (10) Neither tar coating nor cement-grout coating is effective in preventing the absorption of alkali salts from the soil. (11) No advantage is found in introducing ferrous sulphate into the cement mixture.

Engineering Methods Must Replace Paternalism in the Handling of Labor

Scientific Planning Should Be Applied to Industrial-Relations Management and Embrace Whole Field of Employment, Promotion and Housing

By FRANCES A. KELLOR

Assistant to Chairman, Immigration Committee, Chamber of Commerce of the United States

Miss Kellor, who has had long experience in the study of labor conditions and modern methods of dealing with labor, contends that the same process of scientific planning that is applied in other engineering production work should be adapted to work for the men employed in an industry.

THE coming executive in charge of "industrial-relations management" in America's great industries will be the executive with engineering training who can handle men as well as materials. In truth, that is a long jump from the present situation. It is a jump, however, that will be made in the next few years, because it must be made. The determining factors will not be benevolence and sentiment and good nature or a troubled conscience over large profits, but rather the state of the labor market, the increased cost of production and the trade conditions we shall have to meet after war.

The question is, Will the engineer be ready for his widening opportunity for handling men, and will the engineering colleges appreciate the demand in time to give us the necessary trained executives?

Part of Cost of Production

Industrial-relations management will soon be included as a part of the cost of production. It will be administered directly by company employees and accounted for as a risk of business, with expected commensurate returns. This means we shall have to evolve principles, standards and methods for industrial-relations management just as we have for production and sales.

Where do we find ourselves today in handling labor? All the way from the ditched box-car—vermin ridden and disease laden, housing workmen neglected and isolated—at one end of the scale to the Ford plant at the other. We still see the contractor bidding on a contract and including in his specifications every physical thing that entails risk, but leaving the matter of housing, feeding and managing his unskilled labor to the padrone who greatly increases his labor turnover and exploits the men. We are approaching the time when specifications will fix a minimum standard for industrial-relations management, and we shall then see less subletting of contracts and failures of contracting companies.

In the journey from the box-car and construction camp to the mecca now represented by such industries as certain of our rubber companies and zinc and automobile concerns, the pilot will be the engineer, and we shall make progress just in proportion as this matter is considered as engineering and as men are equipped to handle it.

There is today an overwhelming desire on the part of industrial leaders to include industrial-relations management as a part of their plant work. We are in danger, however, of going too fast and of putting in all kinds of makeshifts and experiments, and palliatives and sops to labor, which have no specific organic relation to the administration of the plant as a whole and are not administered in harmony with it. One employer hears of something being done for workmen, and without inquiry or proper planning he adopts it; another puts in a lunch-room; someone else favors a playground; a third has a club building put up for his men. Then when these experiments fail to achieve his ideal or fulfill his dream, he condemns the movement or considers his men unappreciative.

Now I think we are at the point where we may formulate, at least for purposes of discussion, certain fundamental elements of industrial-relations management. These are submitted for the purpose of showing that this field is primarily one for the engineer executive and that the big problem before engineering societies is to see that men are trained to meet the demand that is fast setting in.

Fundamental Elements

Industrial-relations management, expressed in plant location, construction and equipment, is solely the responsibility of the employer. A considerable part of this location, construction and equipment is already the task of the engineer. But when we see day after day splendid buildings put up to house machines and store materials and dispose of products, with little or no thought for the necessities, comforts and conveniences for workmen, then we know the engineer is neglecting the human phases of his work. When we see taxation rates and transportation facilities carefully worked out in advance, but housing and rentals and accessibility of homes to the plant ignored, we know the future labor turnover of that plant has been left out of the calculations of the engineer.

Labor management within the plant is also the direct responsibility of the industry. Its subject matter covers organization of the local labor market, census of employees, physical examinations of the men, promotions and transfers, dismissals, voluntary lay-offs and incentives.

Housing is the responsibility of the industry where private capital will not take the risk, as during temporary business expansion, or where the industry develops faster than the town can meet the situation. We are not agreed, however, on how this should be managed, whether directly by the company, whether houses should be sold to workmen or rented to other than company employees.

Beyond these fundamentals are shadow lines where we are not at all agreed on what the employers' responsibility is.

Processes of an Engineering Project

Let us take the processes through which any engineering project goes and see how they may be applied to industrial-relations work:

Planning comes first, which determines what is to be done and how, embracing calculation, design, drafting, analysis of labor operations and analysis of material requirements.

Scheduling comes second, which decides when a thing is to be done. It is the arrangement of the combination of the result of labor analysis and of material requirements and their assembling in a natural and dependent sequence.

Preparation provides the means, as the assembling of plans, materials and tools, power and light and removal of interferences—in short, the establishment of standard conditions.

Execution comes fourth and covers all the operations from the time the job is turned over to the workman. His success depends upon the suitability and efficient operation of the equipment, the character of supervision, scientific selection and training of workmen, and the method of pay.

Inspection comes last and consists of an examination of the results and comparison with the plans to see that they have been carried out.

Every piece of construction work, every minute product of a factory, goes through these processes. The more thorough they are, the higher the grade of result.

Applying the Processes to Labor

A flaw, a delay, friction at any one of these points, means waste and perhaps failure in mechanical construction and operation. How much more so must it mean these in the infinitely more delicate and volatile human relations of men.

The employer, from some source or other, thinks he should do something for his men. Someone tells him that an employment department would be a good thing; that incentives need to be stimulated; that hospitals and nurses are desirable; that company houses are worth while; that a playground and a clubhouse are good investments; that the men need a lunchroom; that fellowship clubs have possibilities. Then he sets about putting them helter skelter into his industrial system. Does he find out whether the existing structure will carry the load? Where are the weak places to be strengthened? Are the same care and process observed as to the accommodations for men as for machines? Are employment offices operated in the same way as salesrooms and shops? In how many instances does an employer install any method of inspection or insist upon tangible returns for his "welfare" investment?

A machine shop is a perfect environment for getting a specific thing done the best and quickest way by applying the principles of construction and production. An employment office is a makeshift, crippled at one point because some foreman objects to his prerogative being disturbed; at another because some superintendent's authority is handicapped; and somewhere else because each "boss" wants to hire or fire his own men.

Employers Lack Vision

One reason this is so is because employers lack the vision, the courage and the science to meet the labor situation squarely and to organize its administration within their industry with as much accuracy, thoroughness, integrity and impartiality as a bridge is built. When we cease to regard industrial-relations management as an emergency or "rush order" to avert labor troubles and come to think of it as a production measure and as a measure for the conservation of men, we shall have reached the rock foundation upon which we can build.

Another reason is that engineers have too long neglected the human phases of their work; and when they enter executive positions, they sometimes fail because they cannot handle men. The industrial leader has not had from technical men the assistance to which he is entitled.

Basic Principles

In any contemplated installment of measures for successful industrial-relations management the basic principles are these:

1. The principles of construction and of production—planning, scheduling, preparation, execution and inspection—should be applied to the plant as a whole and to every contemplated addition. Any proposal that cannot be so tested and operated should not be included in such management. This method will invariably rule out haphazard, irresponsible, slipshod experiments that have no organic relation to the plant as a whole.

2. The field of industrial-relations management should be limited to company employees and company property. Beyond this the responsibility of the employer is coöperative and his opportunity a community one.

3. The scope of industrial engineering includes (a) labor consideration, which provides measures of safety, convenience, comfort and health in the location, construction and equipment of plants; (b) labor management, which provides standards of industrial justice in the employment, promotion, transfer, dismissal and retirement of men; and (c) labor fitness, which provides incentives and working and living conditions to keep men fit.

Specifications for Industrial-Relations Management

The structure we want to build in industries according to these principles is industrial-relations management by means of industrial engineering, and its two bases are the production of goods and the conservation of men. We may lay down as fundamental standard specifications in the building of this structure the following, upon which considerable agreement has been reached:

Labor Consideration

Successful industrial-relations management has its deepest roots in consideration shown workmen in the location, construction and equipment of plants. A sense of injustice or of neglect is bound to secrete itself in the heart of the workman who cannot get a drink of water on a hot day, who must go home sweat-smeared in his dirty clothes, who must eat his lunch alongside his machine, or who must take his turn in a three-shift bed. No spacious clubroom or playground quite obscures this smoldering sense of injustice.

Labor Management

Risk of the Business—Industrial-relations management should be carried as a risk of the business, accounted for in the cost of production, and be made the subject of itemized reports that show returns. Across every employer's desk should go a monthly statement on men as well as on production and sales, including such items as accidents, labor turnover, incentives, etc. It is never to be considered as philanthropy and accounted for under "donations."

Executive an Employee—The executive should without exception be the employee of the company directly

responsible to it and should be the same grade man as the manager of production and sales. He should have technical and business training. No other executive will eventually succeed, and it is not fair to the men to give them an irresponsible outsider when machines are put in charge of the best ability that can be found.

Central Employment System—An efficient central employment system is indispensable to industrial-relations management. The installment of the principles of justice, which promote men on records of efficiency, which transfer them to obtain better results, which give them a hearing before dismissal, which ascertain causes of lay-offs and make some attempt to adjust them, which give notice of dismissal, etc., will surpass in good results the best so-called welfare measures ever devised.

Concurrent with such a department, efforts must be made by industries jointly to organize the local markets for supplying the workmen's needs on a coöperative instead of a competitive basis. This is a task to which industrial leaders have not yet applied their ability. Of all the markets in the civilized world, ours are the most disorganized, haphazard and inefficient.

The padrone must go. He is the greatest single anti-American factor in the employment world. He is an obstruction between employer and employee and a racial and social barrier against the American-born and foreign-born working, thinking and acting together. He has outlived his usefulness, and industrial progress calls for his elimination.

No Race Distinctions—To many it will seem unnecessary here to say that foreign-born and native-born workmen should be treated identically alike in terms of respect, fairness, opportunities, rewards and coöperation. And yet a few hours spent in almost any plant will uncover most astonishing and often quite unconscious discriminations, based largely upon racial prejudice.

Incentives—We have been singularly indifferent in this country to the value of incentives. We have taken for granted that reduction in hours and increase in wages covered the field. We now know that we have a whole, relatively speaking, unexplored field before us in the way of insurance, pensions, profit sharing and coöperative management, worthy of the best intelligence in the country. The safety-first movement was only a beginning.

Labor Fitness

Safety and Health—The installation by industries of measures to reduce accidents and to decrease occupational diseases, of first aid for injuries and educational work along health lines, is desirable from the point of view of fitness of the workmen. Action that affects others or a group directly, as sanitation, water-supply, garbage collections, etc., should be taken up through the community organizations or by employers collectively.

Rewards for Efficiency—Whenever possible, all plans that result in increased personal efficiency of employees should be followed by increased wage and shorter hours, indirectly giving larger opportunity for recreation and enjoyment of advantages for self-improvement without increasing the unit labor cost of commodities.

Housing—Housing should be carried as a company matter only when private capital will not take the risk, and then should be administered by a separate corporation. Company houses should be rented to others than company men and be sold to workmen. Company stores should not be run except where private capital will not invest, and then coöperative management will reduce the liability of friction. Deducting money from pay envelopes always contains the excuse for disagreements. The same rule applies to lunchrooms. I am convinced, notwithstanding the success of some ventures, that recreation and social functions should center in the community and not in the plant.

Education Through Classes—Education through classes in English and civics is the business of the schools, but the adjustment of those classes with industrial conditions, getting men to attend and having classes in the plant under public-school supervision, is the direct responsibility of the employer.

Aids to Naturalization—Naturalization is the business of government and of schools, but facilitating this by incentives and elimination of hardships (as by furnishing blanks in the plant) is the direct responsibility of the employer.

Town Planning—Town planning is the direct responsibility of the employer, if he starts the town or his industry develops it so abnormally that the city cannot undertake the work.

Social and Recreational Work—Social and recreational work conducted by the industry depends almost always for its success upon the inspiration and personality of the employer or leader and cannot be recommended in principle. The most refreshing social life with the strongest roots is found away from the job, in the community center.

Promotions, Not Prohibitions—Whatever work is undertaken should be constructive and affirmative in the line of building and development and not through prohibitions. For this reason promotions and transfers based on citizenship and language qualifications are sound; but prohibitions against alien workmen are not. This does not, of course, apply to governmental and confidential positions or work in strategic industries in war times, when a different principle applies.

When we consider how few industries have adopted these principles, how many problems remain unsolved, how great the need is, and how eager the employer is to do the right thing in the best way, we realize how big is the opportunity before engineers and engineering colleges; and we turn hopefully to the future, assured that the engineering executive will be our pilot.

Pipe-Laying Costs in Detroit

Nearly 50 miles of water main were laid in Detroit last year at a total cost of $864,732.35. Deducting replacements of 0.95 mile there was a net gain of 48.23 miles, making a total of 1004.84 miles in the entire system. The unit cost per foot of various sizes, shown in the following table, are from the last annual report of Theodore A. Leisen, general superintendent:

COST PER FOOT

Size, In.	No. of Feet	Material, etc.	Labor	Overhead Expense	Total
4	804	$0.56	$0.37	$0.05	$0.98
6	118,523	.64	.45	.05	1.14
8	81,010	.70	.45	.05	1.20
10	2,055	1.28	1.02	.11	2.41
12	3,908	1.58	.96	.11	2.65
16	208	2.64	1.13	.13	3.90
24	5,095	3.74	1.98	.25	5.97
48	29,581	11.74	7.21	.84	19.79

Wooden Roof of Reservoir Fails When Posts Overturn

Edge of Cover, Resting on Concrete Slope Lining, Slips Off, Pushing Roof Over Sideways

By S. B. MORRIS

Chief Engineer, Water Department, Pasadena, Calif.

THE wooden roof of the Wilson Ave. reservoir of the Pasadena Water Department collapsed in an unusual manner shortly before 8 a.m. on Sunday, Mar. 25, 1917. This reservoir was constructed during 1909 and 1910 by the Lake Vineyard Land and Water Co. according to a design by L. A. Bartlett, a local surveyor, and was acquired by the city in 1912. It has a capacity of 13,000,000 gal.; dimensions, 414 x 283 ft., 17 ft. deep, 1:1 slopes. It is lined with 4 in. concrete, except the south wall, which is 6 in. thick, all without reinforcing, and cost $31,000, including the wooden roof. The roof itself cost $8940, or 7.55c. per sq.ft. The construction of the roof is shown by the drawing below. Rough 1 x 12 Oregon pine boards were laid on 2 x 8 joists 16 ft. long, 4 ft. on centers; the joists rested on girders of two 2 x 10's spiked together, spaced 15 ft. 10 in. on centers. The supports under the girders consisted of 2-in. standard-weight pipe dipped in asphaltum and capped at the lower end, while the upper end penetrated about midway into a 6 x 6 x 3-in. corbel.

The photographs show how the roof slid down the east bank and forced itself over the west bank. One 16-ft. section was pushed out across the ground for its full width, while the next 16-ft. section fell against the 1:1 slope. Both north and south ends bent down against the surface of the water without breaking a board. In fact, the only boards broken were a few along the west bank, where the roof broke into two 16-ft. sections extending the whole length of the reservoir.

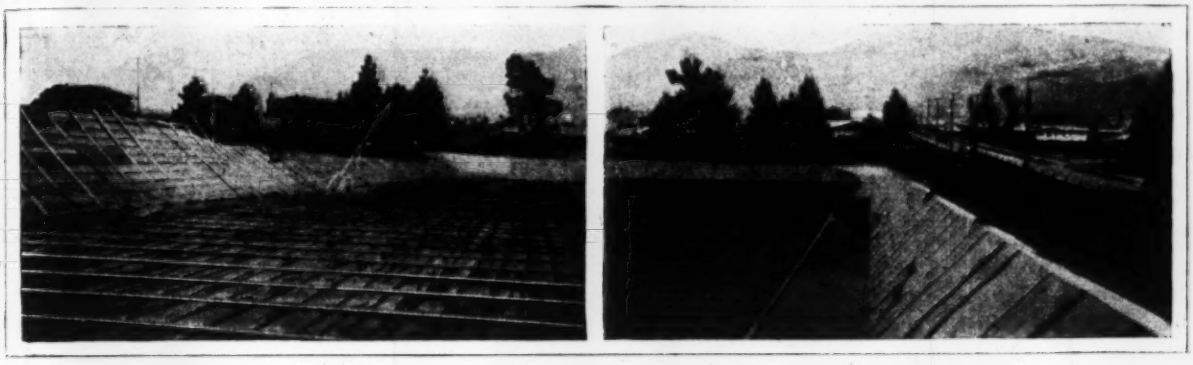
Last winter the reservoir was cleaned, the pipe posts were scraped free from rust and were then asphalted. Both posts and lumber were found to be in excellent condition at that time. Further inspection also indicates that there was no failure of materials to cause the accident.

Cause of Failure

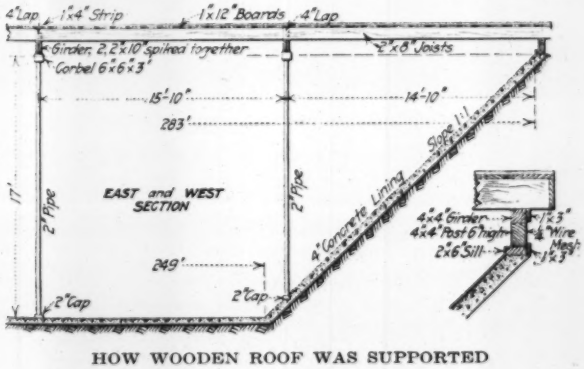
The morning of the accident was perfectly clear and quiet, nor had there been any storm of any kind for some time. The cause of the failure was, however, very apparent after a close examination. The sketch shows how the joists were supported at the east and west banks by means of a 4 x 4-in. girder placed on 4 x 4-in. posts 6 in. high, standing on the 2 x 6-in. redwood sill. Earth and gravel on top of the concrete gave clear evidence of the position of the sill: For nearly the entire length of 625 ft. the sill projected only 2 to 3 in. on the concrete and was very much raised on the outer edge, thus tending to overturn the little posts. This action had apparently gone on for months, with the strains of varying temperatures and dampness.

As soon as the roof started to push westward, it slid down the 1:1 slope, the whole roof moving as one unit. The sills were not fastened in any way to the concrete except by weight, nor was there any bracing of any kind used in the roof.

The city has several other reservoirs with similar roofs, it being the most common type in this district. One city reservoir of 18,000,000 gal. capacity has the same type of roof, now 18 years old, though in poor condition. As far as the writer is aware, this is the first complete failure of this type of reservoir roof.



THE ROOF SLID DOWN THE EAST BANK AND FORCED ITSELF OVER THE WEST BANK



HOW WOODEN ROOF WAS SUPPORTED

What Traffic Can a Road Carry

There is no agreement among engineers as to the number of vehicles per day for which pavements of different types are economically suited, but an indication of the range is given by the following limits tentatively adopted by the State Highway Department of Michigan: 9-ft. gravel roads, up to 200; 16-ft. gravel and macadam roads, 200 to 500; 16-ft. macadam roads and bituminous surfacing, 500 to 1000; 16-ft. concrete roads, 500 to 2000.

Prospects for Civil-Engineering Activity Indicated by Reports from Many Industrial Centers

Middle West Very Busy, but Both Atlantic and Pacific Coast Districts Dull, According to "Engineering News-Record" Correspondents

IN RESPONSE to an inquiry sent out to its correspondents in various parts of the United States, *Engineering News-Record* has received the following reports on the prospects for engineering activity during the coming season. All these reports were sent in before the entry of the United States to the war was assured, and all are subject to whatever revision or restriction that action entails. No one knows certainly what the effect of the war will be on engineering work, but it seems safe to predict that most industrial activities will be stimulated and that most of the public work under construction will be carried through. Curtailment may be expected in the projection of new enterprises or in extensions for which new funds will have to be provided.

These appended reports show that both coast districts are dull, but that the agricultural prosperity of the Middle West is reacting in increased industrial and governmental construction, which, though not individually large, totals to sizable proportions. It is evident that from the Ohio Valley to the Rockies engineering jobs are more numerous than the engineers to fill them.

Boston and Eastern New England

Proposed engineering developments in eastern New England, while not extensive, have some interesting features. Probably the largest work at present under construction in Boston proper is the new dry dock being constructed by the Massachusetts Waterways Commission, to cost some $3,500,000.

Prospective work by the Boston Transit Commission is not large and consists principally in the completion of the Dorchester tunnel. The Metropolitan Sewerage Commission has under construction a new outlet at Dear Island in Boston harbor. This will discharge into deep water through a multiplicity of openings in the latest approved manner. This construction is of interest as an illustration of the course of education taken by the officials of Massachusetts and Greater Boston, through lessons learned from observations of the effect of sewage discharge at the various outlets in Boston harbor and other coast cities. At Providence there is about to be put under construction one of the largest water-supply projects in this part of the country, amounting to some $8,000,000 or $10,000,000.

A good deal might be said concerning the experiments and amount of money being spent by communities and particularly industrial interests in eastern Massachusetts in their struggle with the stream-pollution problem, but much of this is still in course of development.

Boston. W. L. Butcher.

Baltimore and Maryland

The field of engineering in Baltimore and in Maryland is bright with possibilities. The excellent advantages of Baltimore's harbor have attracted many factories and manufacturing plants to locate on its shores, for the chief of which, the Bethlehem Steel Co. plant located at Sparrows Point, an entire new city is being built on adjacent ground to house and home its many thousands of increased labor force. Paving in Baltimore is being rapidly pushed, and $2,000,000 will probably be spent on the city's streets this coming year. The Pennsylvania R.R. is at present arranging with the city government to improve its lines and freight-handling facilities through the city. The tentative plans of the company contemplate the expenditure of some $12,000,000 inside the city limits on tunnels, extra trackage and enlargements of stations. Street-car congestion is reaching such a point that subways for Baltimore will have to be seriously considered in the very near future.

Engineering will keep step with the manufacturing and commercial interests of the city and state; more money is being spent at present in increasing old enterprises and in developing new ones than has ever been the case before.

Baltimore. G. J. Requardt.

In Both the Carolinas

Much construction work is under way and projected in the Carolinas for the near future, especially in the way of road building, which has been stimulated by the prospect of Federal aid. In the way of municipal improvement the City of Durham, N. C., will spend $1,000,000 for streets, and 18 other cities and towns in the Carolinas will undertake municipal improvements amounting to $1,500,000.

The Southern Ry. will continue the work of double tracking the main line between Washington and Atlanta. All the frame trestles between Morristown, Tenn., and Salisbury, N. C., will be replaced with permanent structures of steel and concrete. New passenger stations will be erected at Asheville and Winston-Salem.

Drainage work to the amount of $120,000 is proposed in the Grant Creek drainage district near Salisbury, N. C. The most important hydro-electric project is that of the Southern Power Co., at Wateree, S. C., on the Catawba River, to generate 100,000 hp. It is to cost $5,000,000. Work has been started by the contractors.

Charlotte. S. H. Lea.

In the Vicinity of Pittsburgh

The condition of the Pittsburgh district, as far as engineering work is concerned, is well shown by the fact that the "Men Wanted" items published in bulletins of local engineering societies outnumber the "Position Wanted" paragraphs by two or three to one. And the niches to be filled call for men of experience to handle responsible jobs—by no means for beginners in the profession.

The largest single engineering project ahead of Pittsburgh—or rather, Allegheny County—is the raising of

seven bridges across the Allegheny River, at the order of Secretary of War Baker. This move involves the redesigning of all the bridges affected and will require the expenditure of from $8,000,000 to $10,000,000 on structures and approaches.

The City of Pittsburgh is now considering a municipal budget of about $9,000,000, to be divided for construction and maintenance of sewers, streets and bridges, outside of any possible participation in the bridge-raising work over the Allegheny River.

In addition to the two large projects listed, the bridge now being built by the Bessemer & Lake Erie R.R. over the Allegheny River is the largest bridge job in western Pennsylvania, although there are numerous other projects contemplated which will call for large tonnages of steel and still further drain the local labor market.

The construction of big buildings in the downtown section approaches a lull, with the practical completion of the Union Arcade, the Chamber of Commerce Building and the City-and-County Building—though here again there are listings of numerous smaller structures on which work is scheduled to begin shortly or on which even the preliminary steps have yet to be taken.

Pittsburgh. C. C. Lynde.

Cleveland and Northern Ohio

A measure of engineering activities in this district is the space devoted to their description in technical journals. The Miami Conservancy District, the Brooklyn-Brighton viaduct and the Detroit-Superior high-level bridge are easily brought to mind. Bonds to the amount of $5,000,000 have been voted for building the Huron Road bridge and straightening a section of the Cuyahoga River, and $12,000,000 will be spent in paving in the City of Cleveland in the next five years. The new Union Station, a unit of the group plan, and the high-level warehouse and freight yards of the Cleveland & Youngstown R.R. will go forward to early completion.

Any outline of engineering activities, however brief, would fail of completeness unless it mentioned those other opportunities higher than the making of inanimate things. The Cleveland Engineering Society affords a way by which local engineers take part in civic affairs and are helpful to each other in the problems of daily life.

Cleveland. C. E. Drayer.

Cincinnati and Its District

The general tendency is toward a rather modified schedule of engineering activity in the Cincinnati district, the cause for which is due to the prevailing shortage of labor and materials and its corresponding effect on costs, as estimates for public works made six months ago are practically valueless.

In the City of Cincinnati a corps of engineers and assistants will start on the contract plans for the $6,000,000 rapid-transit loop, should the electorate on Apr. 17 render an affirmative vote and thereby ratify the terms of the lease of the loop to an operating company, in which event it is expected that a number of sections of the project will be ready for contract before the end of the year. Funds in the amount of $1,638,000 are available for ten extensive street improvements, five of which it is expected will soon be advertised for proposals. Plans are practically completed for the 10-mile intercepting sewer paralleling Mill Creek, and the six remaining contracts for this work are to be awarded during 1917. The estimated total cost of this interceptor is $2,000,000. Plans are in progress for two large concrete bridges approximating $260,000 in cost, and the elimination of a grade crossing over the Pennsylvania R.R. tracks at a cost of $150,000.

The Water-Works Department will complete the construction of a battery of five storage tanks in the Eastern Hills district, which will provide an additional storage and equalizing capacity of 4,700,000 gal. of filtered water. On the high-pressure fire system in the business district, estimated to cost about $800,000 and 50% completed, the construction work for 1917 will be limited to that length which can be built from the stock of cast-iron pipe, valves, fittings, etc., on hand, which limitation of work is due to the advance in price of these materials.

Outside of the several corporations in Hamilton County, the commissioners will pave eight highways estimated to cost $750,000, repair 100 miles of roadway at an estimated cost of $125,000 and oil 196 miles of main road in the county.

Rapid advancement toward the realization of a union depot and terminal is predicted, as the trustees of the Cincinnati Southern R.R. have been given authority by state enactment to issue bonds in the amount of $20,000,000, subject to ratification of the electorate of the city, for the purpose of building the depot, or to cooperate with the other railroads in the construction of a union terminal depot.

Cincinnati. J. E. Root.

"Dynamic Detroit"

Dynamic Detroit continues to boom, and construction operations of every sort are projected and in progress in all parts of the city. It is doubtful if prospects for engineering activity are equaled in any other city in the country. To those who have not first-hand knowledge of the situation in Detroit, these comparative figures will help tell the story:

DETROIT'S GROWTH

Year	Population	Area, Sq.Mi.	Building Contract
1910	465,700	40.8	$17,225,945
1915	678,700	41.8	32,235,550
1916	755,000	72.8	51,067,110

There are no indications of any slowing down in this remarkable growth, and 1917 promises to be a record year in construction work. In fact, lack of housing facilities alone prevents the growth from being even more rapid. The land is subdivided for several miles beyond the city's limits. In these newly opened districts streets, drains and dwellings are in process of construction. There is an abundance of work in all these lines.

The engineering departments of the city government are doing their best to cope with the situation, especially in extending the water mains and sewerage system. The construction program for the current year includes laying 100 miles of water pipe and over 30 miles of large trunk sewers, as well as lateral sewers and drains and large expenditures for pavements.

A bond issue of $8,500,000 has been requested for trunk sewers, and there is little doubt that this amount will be approved and available July 1. These trunk lines are part of a comprehensive plan of sewerage that includes intercepting sewers and sewage treatment.

Other projects that shortly will mature are the completion of a main library building, with an expenditure of $1,400,000, and a concrete arch bridge connecting Belle Isle Park with the mainland at an estimated cost of $2,000,000.

Detroit also is facing two vital problems that demand prompt action—the purification of its water-supply and rapid and adequate street-railway transportation. As the first step in the direction of better water-supply an experimental filtration plant has been constructed. Congestion of the streets with motor traffic, combined with the dense and extensive growth of the city, is forcing the street-railway problem to the front, and the construction of a system of subways cannot much longer be delayed.

Grade separation is also a live issue, and very shortly action may be expected from the State Railroad Commission ordering the separation of 45 grade crossings along the line of the Grand Trunk R.R.

Detroit. H. S. Morse.

Chicago District

More work than men to do it describes the outlook for construction activities from the viewpoint of contractors in the Chicago district. Contractors of large buildings say there is planned much more than can possibly be constructed with the men available. Road contractors are bidding high; no concrete-road contractor who knows his business is this year bidding less than from $1.50 to $1.75 per sq.yd. The road and paving program is larger than ever before, but it can hardly be carried out on account of the inability to get men. The county has $1,000,000 with which it wants to build 60 miles of road, and the city's program will run to $6,000,000.

The Sanitary District of Chicago plans to let sewer and pumping-station contracts aggregating $1,500,000 in the Calumet and Des Plaines regions. The city will probably spend an equal amount for sewers.

In the bridge line, Chicago has an unusually large program under consideration—the Clark St. bridge at $600,000, the Franklin-Orleans at $946,000, the Madison St. at $450,000, the Wells St. at $1,240,000 and the 12th St. at $1,300,000. For this year the budget allows $1,600,000 to be spent. Contrary to general opinion, the Rush St. bridge, the boulevard link proposition, so long held up, will be out of the courts inside of a few weeks, and work on this $9,000,000 improvement stands a very good chance of going ahead late in the season. Practically all the above work will suffer for lack of laborers in case of a large draft of men for war.

The railway-terminal and additional track facilities are wholly inadequate to meet even natural-growth requirements. This was shown so strikingly last winter that expenditures are now absolutely forced. The strike on the $1,500,000 Pennsylvania freight station has recently been settled, and work on the program involved in the construction of the Union Station, to cost $47,000,000, is going ahead at top speed. The Burlington freight terminal will probably run to $2,500,000, and its track-elevation work at Aurora and cutoff west will aggregate $4,000,000. The Chicago & Western Indiana R.R. let a contract last week for a loading track involving 30,000 cu.yd. of concrete. The Chicago & Northwestern R.R. has just placed a contract for an exceptionally large amount of concrete for foundations for the season's quota of bridges.

In the St. Louis District

In spite of the exceedingly high prices now current, nearly all phases of construction work in this vicinity are proceeding on a large scale, and as a consequence, services of trained engineers and architects, as well as draftsmen and other co-workers in the engineering field, are at a premium.

St. Louis is faced with the biggest paving program in 10 years; and though practically all of this work is financed by special taxation, there is an incessant demand on the part of the property holders that the work proceed. Prices for paving work vary from 15 to 30% above those of two years ago, and for sewer work up to 40%. The City of St. Louis is also preparing to vote on a bond issue of about $15,000,000 for large permanent improvements, among them the River des Peres drainage, improvement of the river front and relief sewer construction.

Nearly all the small cities in this district have some paving and sewerage work under way or in preparation. The outlook for county road construction is also exceedingly good, and several of the counties have issued bonds for permanent improvements. The state legislature has also passed on a bill for state aid and road improvements, which will make available for this class of work about three times the amount of the Federal aid appropriation.

The building work in St. Louis and vicinity is very heavy, the great amount of it, however, being in mill buildings and industrial structures, as there seems to be a very marked tendency for industrial expansion.

Among the railroads there has been only one project for extensions which has come to a head; that is, the new cutoff line of the Burlington & Santa Fe, which is to give an entrance for the Santa Fe into St. Louis. This line has been surveyed, and bids have been received for grading. All the big railroads centering in St. Louis have, however, elaborate programs for the development of their present property, none of which are affected by the present high prices. W. W. Horner.

St. Louis.

Small Cities in Kansas

Activity in water-works construction in the smaller towns will apparently be curtailed to some extent on account of the high price of materials. Several small towns that have already voted bonds have decided not to build at present. Sewer construction and paving will be more plentiful than ever, it seems, on account of the general prosperity. I do not know of a single idle engineer. Jobs are plentiful.

The oil business seems to afford work for many engineers, in geology, pipe-line and refinery construction and surveying. C. A. Haskins.

Lawrence.

Kansas City and Its District

"The Heart of America" is growing so rapidly that there always seems to be a steady progression of large engineering projects in all stages from inception to actual completion. Without considering work that is in course of construction, a mere list of work that will probably be commenced this year will fill the allotted space.

In Kansas City, Kan., the Kansas City Terminal Ry. Co. will spend an additional $7,000,000 on two passenger stations, street viaducts, yards and other terminal facilities. The city will also undertake the construction of at least three viaducts in addition to the usual $500,000 of street improvement and sewer work. The Kaw Valley Drainage Board has some additional levee work to do and has ordered the reconstruction of the last railroad bridge that presents a flood menace.

In Kansas City, Mo., municipal work will amount to more than ever before and will include Beardesley Ave. trafficway, $150,000; 23d St. viaduct and trafficway, $750,000; Blue River sewer, $1,250,000; Turkey Creek diversion, $440,000; Turkey Creek sewer, $1,000,000; East Bottom flood protection, $800,000; three bridges over the Blue River; the reconstruction of the 4th St. viaduct, $110,000; district sewer work in contracts up to $100,000, approximately $1,500,000; street paving, grading and boulevard and park improvements, over $1,500,000. The building permits will exceed last year's, a total of $12,000,000, as two or three large office buildings and several industrial plants are projected. The enlargements of the oil fields well into Kansas has brought three refineries to Kansas City, and there is considerable activity all through the oil fields. The Kansas City Stock Yards Co. has commenced the enlargement and reconstruction of practically its entire plant at an estimated cost of $3,000,000.

North Kansas City, the Armour-Swift-Burlington industrial city across the Missouri River, will see at least two good-sized factories under construction before the end of the year.

The United States Government will continue revetment and dike work along the Missouri River below Kansas City to the extent of over $800,000 annually.

With the passage in both Missouri and Kansas of workable good-roads laws, it is expected that at least 800 miles of hard-surface roads in each state will be contracted for this year, while the public-improvement work in the towns and small cities of both states continues with the same remarkable vigor of last year. C. R. Mandigo.

Kansas City.

Austin and the State of Texas

During the last year there has been such unusual activity all over the State of Texas in matters directly affecting the engineering profession that it is peculiarly significant of the awakening of the public in general to the realization of the important part that engineers should have in the shaping of public affairs and obtaining efficiency and economy in the expenditure of public funds.

In spite of the setback caused by the European War, conditions never were so favorable for engineering activities in Texas as at present. Dean T. U. Taylor, of the School of Engineering of the University of Texas, had 18 applications for engineers from towns and cities during the months of January and February of this year.

Municipal work probably offers more opportunities than any other phase. Having become effective in January of this year, the stream-pollution law has created quite a demand for sanitary designing and construction engineers. About 200 towns and cities are affected by this law. Many of these are just now taking steps to construct sewage-disposal plants in accordance with its instructions.

The state legislature recently passed a state highway bill with an emergency clause that makes it immediately effective. This will call for many jobs to be filled, from highway engineer to rodmen. Last year, $35,000,000 was spent for good-road building in Texas. This year, it is likely that $100,000,000 will be spent for good roads. The outlook is very promising for highway engineers.

From the bright outlook for engineering activity in the state, there should be a great reduction of the percentage of unemployed engineers and many opportunities for those seeking advancement.

In Austin the features of interest to engineers at present are the construction of a sewage-disposal plant and the perennial revision of the Austin dam.

Austin. Julian Montgomery.

Minneapolis and St. Paul

The outlook for engineering activities in the Northwest is promising. Work started Mar. 15 on St. Paul's new union station and passenger terminal, which will require four years to complete at an expenditure of $11,500,000.

The first 6-mile link of the Twin Cities Belt Line R.R. will be built this year at a cost of $2,000,000, to relieve the Union Station tracks of freight traffic. Buildings on 33 blocks have been, or are being, razed for two industrial terminals, their immediate construction also being due to the new station plans. The Great Northern freight terminals will cost $2,500,000, and the Soo industrial district involves an expenditure of $1,000,000.

With the acceptance of the new union-station plans the riparian rights to ½ mile of river shore and a 45-ft. levee revert to the city. The first unit of a municipal dock, for which $50,000 has been appropriated, will be built at once, and plans for 3 miles of levee will follow. The engineering department of the city, in addition to handling a program of some 26 miles of sewer construction and 200,000 sq.yd. of pavements, finds itself with the largest amount of work in its history, for many of the details of all the above work must be passed upon by the department.

Other railroad-construction activities will be curtailed very largely while present labor conditions exist and until something further is known of the attitude of the Interstate Commerce Commission toward railroad valuation and rates. There is an undoubted undercurrent of thought in railroad circles of the futility of improvement expenditures, considering the present trend of events.

Laying water mains in Minneapolis will be curtailed this season, due to the high cost of pipe and fittings. Bids for pipe have been rejected, and only such extensions will be laid as are absolutely demanded. St. Paul has purchased pipe and fittings for 10 miles of extensions at a premium of $25,000 over last year's prices. Minneapolis is preparing plans for a 30,000,000-gal. filtration plant, an additional unit. The normal capacity of the present plant is 52,000,000 gal. Plans and specifications have been completed for St. Paul's new 30,000,000-gal. storage reservoir for lake water, and the contract has been awarded for $246,000.

Minneapolis has asked the legislature to permit her to issue $5,600,000 in bonds for new schools, to be expended in five years, $1,250,000 for a municipal auditorium and $550,000 for bridges. Bonds for $595,400 have been sold

for 74 street-improvement jobs, and $500,000 offered for sale for sewer extensions.

Many plans for reinforced-concrete building construction in the Twin Cities are in the making, with little likelihood of actually reaching construction this season, on account of the high prices.

Throughout the state there will be a large amount of road construction, 1500 miles of permanent grade, 1200 miles of surfacing and macadam and 400 bridges being planned for 1917, under the State Highway Commission. The expenditure will be $5,805,000.

Work in the field of sanitary engineering, such as water-supply and sewage disposal, can be interpreted by the activities of the Division of Sanitation of the State Board of Health. Field and laboratory examinations and the examination of plans for sanitary works have increased 285% over the biennial period of 1910 and 1911. Drainage work in the state is estimated at $6,000,000 for state, judicial and county ditches, but not including private work.

At the head of the Lakes the construction of the $4,000,000 steel ore dock of the Duluth, Missabe & Northern Ry., the 600-ft. extension of the steel ore dock of the Northern Pacific Ry. and the plans being drawn by the Duluth & Iron Range R.R. for a new steel dock to replace a wooden one now being razed are the prominent features in engineering work this year.

St. Paul. GEORGE H. HERROLD.

In and About Colorado

Because of generally unsettled conditions it is difficult to forecast with any degree of certainty work that will be done along engineering lines. The situation is complicated not only by the financial situation, but also by the difficulties of getting satisfactory labor and what seems to amount to almost an impossibility of getting supplies within any reasonable time after ordering, all these conditions being due largely, of course, to the European complications. In general, however, the engineering outlook in Colorado and vicinity may be briefly summed up as follows:

Little new railroad construction, either steam or electric, will be undertaken within the near future. If the railroads undertake the valuation of their lines, as has been promised, on any adequate scale, there will be an important field for engineers opened in that direction, but this seems doubtful.

Comparatively little new municipal work will be undertaken. Some minor new sewer and water systems are proposed, and some important additions to existing plants are promised, the most notable being at Denver and Colorado Springs.

But little new work will be undertaken along irrigation lines, but there is considerable activity in drainage, particularly in the San Luis, Arkansas, Grand and South Platte Valleys.

Naturally, mining is active, and much capital is being invested not only in the production of all the metals, but also in the development of mineral oils throughout the Rocky Mountain region. This is particularly true of Wyoming and New Mexico.

Much building activity is being shown at the present time. Several sugar mills are being constructed and also several pickle and canning factories and other plant related to agriculture, now the master art.

Probably rather more than the average amount of construction will be done by the Federal Government, along practically all lines, but particularly of roads.

In general, it appears that, while the situation could be more encouraging, local engineers should not feel disheartened. The engineer of the Rocky Mountain region, however, like his brothers both East and West, will have to adapt himself to more or less changed conditions.

Denver. A. LINCOLN FELLOWS.

Los Angeles and Southern California

The proposed engineering activities for the coming year in Southern California are particularly bright. The State of California and most of the southern counties are planning to extend the paving on the present system of concrete highways. Tulare County recently voted a bond issue of $2,200,000 for this purpose.

The reconstruction of the Lower Otay Dam, which failed during the flood of Jan. 27, 1916, will be undertaken by the City of San Diego. Extensions in the southern part of the state will be made by Santa Fe, Salt Lake and Southern Pacific railways. Construction work is being rapidly pushed on the Lindsay-Strathmore and Terra Bella irrigation districts in Tulare County. Los Angeles County voted a bond issue for $4,500,000 on Feb. 20, 1917, for the controlling of floods on the various streams in the county. The bond issue carried by a small majority. However, it is expected that construction work will start within a few months. A new headgate on the Colorado River and extensive canal work are planned by the Imperial irrigation district.

Plans have been prepared and bids were received on Mar. 26, for construction of the 2nd St. tunnel at Los Angeles. The addition gives the city four tunnels built to relieve the traffic congestion in the business section. Los Angeles is planning additional construction work on the outfall sewer at Hyperion. The Los Angeles Water Department has laid practically 80% of the steel pipe required for the Los Angeles County Water-Works District No. 3. This district comprises 76,000 acres, all of which is within the city limits. The city's hydroelectric plant in the San Francisquito Cañon, composed of three units of 12,500 hp. each, is ready for operation. This plant is part of the power-development plan in connection with the Los Angeles aqueduct.

Los Angeles. KENNETH Q. VOLK.

Portland and the Northwest

For Portland and vicinity the prospects for contract and engineering work are better than for the past three years, but not yet back to what may be considered a normal status. The industry which governs all others in this section is that of lumbering. With lumber prices much improved, the lack of ships and the car shortage have restricted the output to very much below capacity. The lack of tonnage has also practically stopped the foreign shipment of grain through this port, which has in other years been a large business.

A most important new industry which has developed during the past year is that of shipbuilding. There are now in Portland alone four shipyards handling steel construction, having a total of 20 ships contracted for.

There are also within the city six yards handling composite and wooden motor ships, with a total of 22 ships contracted for. There are on the Columbia River and directly tributary to Portland several other yards building wooden ships, with probably 15 other ships ordered. The total cost of these ships will approximate $25,000,000. This industry, with its attendant branches of machine work, fittings and cordage, makes a total payroll of considerable proportions. The building of wooden hulls and the construction of ways, sheds and shops have also furnished an outlet for many millions of feet of lumber.

In private-contract work there is only moderate activity. The only new railroad work is that projected in central Oregon by Robert E. Strahorn. As a result of the good freight business the railroads are giving increased attention to betterments. Several hundred wooden freight-cars have been ordered from local builders.

Several irrigation and drainage projects of merit are awaiting only the placing of their bonds to begin active operations. Among these may be mentioned the Ochoco, Warm Springs and Kittitas irrigation districts.

The principal public-works contracts under way in Portland are the regrade of the Oregon, Washington Ry. and Navigation Co., which will cost about $700,000, and the Tanner Creek sewer job, amounting to $300,000. There are in prospect a municipal electric plant costing $1,700,000 and grain elevators costing $3,000,000, contingent upon the passing of bond issues submitted to popular vote. There is also to be voted upon a $6,000,000 state bond issue for hard-surface pavements.

Portland. J. W. CUNNINGHAM.

Well-Designed Wire and Concrete Fence Incloses Reservoir Property

Decorative Features Important in Marking Off Catskill Aqueduct Land Near Residential Center

BY ARTHUR W. TIDD

New York Board of Water-Supply, Southern Aqueduct Department, White Plains, N. Y.

A WIRE fence with reinforced-concrete posts and intermediate steel posts, giving a pleasing appearance, has been built around a large equalizing reservoir known as Hill View, on the line of the Catskill Aqueduct, near Yonkers, N. Y. The 160-acre reservoir is of the earth-embankment type, and its construction involved placing 3,000,000 cu.yd. of material. It is situated in a well-developed residential section. An important element from a decorative point of view is the woven steel fence.

The horizontal and vertical wires and locks are No. 7 (American Steel and Wire Co.'s gage), while the fastenings to the steel posts are No. 9. The steel posts are 3x2½-in. T's weighing 6 1/10 lb. per ft. and braced where necessary. All exposed metal was heavily galvanized subsequent to bending, threading or punching. The eye-bolts in the concrete posts were Richmond screw anchor-bolts. The fence is 12,400 ft. long and comprises 1274 steel posts, 41 end and corner posts and 227 intermediate concrete posts.

At each side of each opening and at angles greater than 15° the larger concrete posts were used. Between these

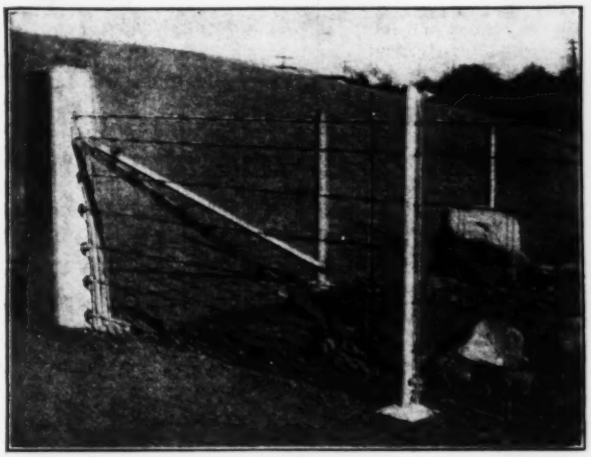


FIG. 1. CORNER OF FENCE INCLOSING HILL VIEW RESERVOIR NEAR YONKERS

the intermediate concrete posts were placed about 48 ft. apart. These posts took no strain except the side pull on curves or at slight angles, the wires being loose in the holes through the post. Between the intermediate concrete posts the steel posts were set 8 ft. apart. The straining posts were placed about 400 ft. apart on the long stretches between end or corner posts. No transverse braces were built. The sharpest curve was 439 ft. long on a 550-ft. radius. Wherever the property line was on a curve, all posts were set to conform to it. Changes of grade in the profile were made to come at the concrete posts.

The fence was built entirely on city property, with the face of the largest posts flush with the property line except along highways, where the fence was set back 4 ft. from the line. The work was begun and completed during the summer of 1915, and no signs of any movement are visible at the present time.

DIFFERENT TYPES OF POST

The corner and end posts are 8½ ft. long and are set 5½ ft. in the ground. The steel posts are set in a concrete base extending 3 ft. into the ground. All posts were cast in place, special steel forms manufactured by the Blaw Co. being used for the exposed portion. Wherever possible, the post hole was dug to the minimum size and depth; but where enlargements occurred, as at boulders or stumps, the entire refill was of concrete just the same. Accurate line and grade were given for each concrete post, but the steel posts were lined in with a string by the inspector at the time of setting. The alignment and grade were established by studies made in the office to fit the final grading scheme of the reservoir embankment. This often resulted in the hole as dug not being of the full depth shown on the drawing, for the reason that the final grading and placing of top soil were not completed prior to casting the posts.

In building the end or corner posts the reinforcing metal was carefully plumbed and centered, the steel form placed in position and braced in all four directions with wooden braces and the post concreted as a monolith. In the case of the intermediate concrete posts the reinforcement was set and the hole filled with concrete about to the surface of the ground, leaving the setting of the steel form

and completion of the post until the following day. The forms extended 6 in. below the final surface of the ground.

The concrete was poured into the form through the open top. A specially constructed long-handled narrow spade was used to compact the concrete and to make a smooth face on the post. The form was also tapped with a hammer at intervals to help expel the entrapped air. Settlement of the concrete in the form continued for several hours after filling, and when it had ceased, the post was finished with mortar, the pyramidal top being formed by a trowel.

After this, the forms were left in place for from 24 to 72 hours, depending upon weather conditions. They were removed as soon as the posts could be rubbed without injury, as it was found by experimenting that the most pleasing surface was produced by rubbing with a wooden float while the concrete was yet somewhat soft. Holes 1 in. in diameter through the intermediate concrete posts were formed by round rods in pasteboard tubing, the tubing being left in place when the rods were withdrawn.

The steel forms were constructed of four pieces of ¼-in. sheet steel bent out at the edges to form flanges about 2 in. wide, by which the sides were bolted together. A stiffening and supporting collar of 3x4x¼-in. angles was placed around the form at top and bottom. The forms were drilled for the various bolts and rods, the holes not in use being plugged with cork stoppers during concreting.

Concrete Pouring and Forms

Crushed traprock of 1¼-in. size and natural sand were used for concrete, the mix being 1 : 1.5 : 2.5. The concrete was hand mixed alongside the posts. The concrete base for the steel posts was built in one operation, a wooden form being used for the upper 10 in. and the beveled top finished with a trowel and mortar. No bracing was required for the post.

The wire fencing was fabricated in place by the Kno[illegible] Fence Co., under an agreement with the principal contractors for the reservoir. The line wires were strung between corner or straining posts and each given the proper tension and held by means of light double-block tackle. The stays (or hairpins, as they were locally called) were then fastened to the line wires by wire locks set up with a special clamping tool. As each lock shortened the line wire about ⅛ in., the tension had to be relieved from time to time at the blocks. The stays were always set vertically, and the adjustment of the tension,

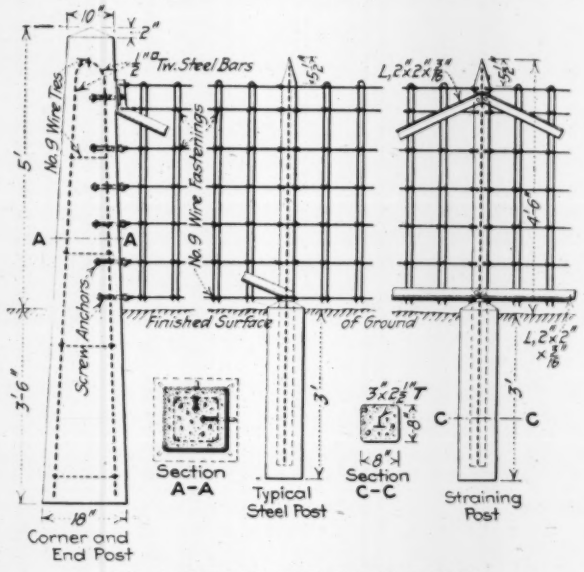


FIG. 3. DESIGN DETAILS OF FENCE

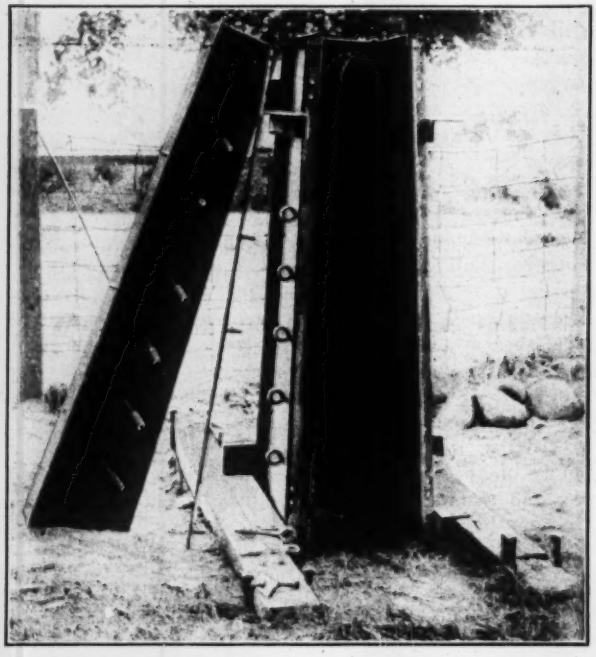


FIG. 2. POST FORM ERECTED AND REINFORCING STEEL IN PLACE

especially on grades, required considerable experience to avoid throwing out of plumb the stays already set. The last operation was to bind the line wires to the steel posts, which was done with short pieces of wire and a light hand tool for twisting. One mechanic with helper built most of the fence. The length of wire fence fabricated and tied averaged 200 ft. daily. The cost of the fence, earthwork, concrete, wire, etc., on the basis of the contract prices, was $1.41 per lin.ft.

J. Waldo Smith is Chief Engineer of the Board of Water Supply, and Department Engineer Frank E. Winsor and Division Engineer Charles E. Wells were in charge in the field. The contractor was the Keystone State Construction Co., of Philadelphia.

Abandoned Coal Mines Give Trouble

Abandoned coal mines whose gallaries reach within 30 to 50 ft. of the surface frequently cause small areas of ground in the streets of Pittsburg, Kan., to sink when excavations are made for paving. Ordinarily, this causes little trouble, as it is usually a patch of ground but a few feet square that sinks only 4 or 5 ft. However, on one recent occasion the spade of a workman opened a hole into which a 16-ft. plank was dropped out of sight. These mines have been abandoned for 20 years, and the wooden shoring now rotting away is the cause of the trouble.

Leading Engineering Schools Throughout Country Work for Military Preparedness

Plans are Under Way in Colleges To Mobilize the Men and Equipment for Both Industrial and Military Service

THE story was told last week of what the leading engineering societies of the country are doing to express their patriotic sentiment and aid the Government in its work for national defense. In many of the leading engineering schools during recent weeks, opportunity has been sought to make public expression of the sentiments of the faculty and students in favor of patriotic action, and also to place the facilities of the institutions at the service of the Government and to train students in various branches of military science. In response to requests from this journal the heads of a number of the principal engineering schools have briefly summarized the action taken at their respective institutions, and the reports are presented below.

Two noteworthy features in connection with these reports are that, as a general rule, even in the institutions that are doing most for preparedness, the under-classmen are advised to remain at their studies, and the upper-classmen, if they leave college work for the service of their country, are advised to undertake work for which their technical qualifications fit them to be of especial service. It is realized now that the manufacturing and industrial equipment of the nation is just as important to its success in warfare as the size and efficiency of its army in the field.

In making these statements, however, the qualification should be made that, should legislation for universal military service be enacted, as is almost unanimously desired by engineers, a considerable proportion of the under-classmen in the colleges must respond to the call; also, if half a million or a million recruits are to be called to the colors, it will be necessary to utilize for the training of these recruits a very large proportion of the upper-classmen who have already had some elementary work in military drill. Some of the reports from the institutions follow.

University of Pennsylvania

About 1500 students and 125 members of the faculty are engaged in drilling and intensively studying the minor field and drill regulations. We also have a large aviation corps started and will receive three machines in a very short time. We are also organizing a machine-gun company. The National Research Council has been organized with a committee at Pennsylvania, and already certain research work at the request of the Government is going on.

William McClellan,
Dean of Wharton School.

Lehigh University

Lehigh University was one of the first institutions to respond to the call made by the War Department, through Major-General Wood when Chief of Staff, in the spring of 1913, to coöperate in the establishment of the summer military-training camps, which have proved to be so valuable an adjunct to education and so potent a force in training a body of educated young men for readiness for military service, if needed.

We believe that the five weeks' intensive training received in these camps is of greater value than any desultory course of training scattered through the year, and we have encouraged our students to take it. We have under consideration supplementing the military-training camps with some measure of military instruction, by way of lectures and reading under the direction of the War Department, and voluntary drill is now being pursued in our department of physical education.

We indorse and are being guided by the judgment of General Wood, that the present situation does not yet call for retirement of students from their courses. On the contrary, we believe, especially in the case of students who should graduate this year, that they will be of far greater value to the Government if they finish the year's work.

H. S. Drinker,
President.

Massachusetts Institute of Technology

Modern developments have placed the conduct of a war on the skill of engineers—mechanical, electrical and chemical—fully as much as on the fighting qualities of armies. On the rolls of former students of technology are the names of the majority of the United States naval constructors, and from this school have graduated most of the heads of the Aviation Section of the Signal Corps.

President Maclaurin offered to the Government, the moment that President Wilson terminated relations with Germany, the services of the entire instructing staff and of the laboratories. This means an efficiency of service that can be afforded by a faculty of trained men, working in laboratories with which they are thoroughly familiar. President Maclaurin awaits only the word to set in motion this unequaled resource.

With reference to the students and their preparedness, Technology being a "land-grant" college, military work is obligatory and has been for 40 years. Every freshman must take the military courses and the military drill.

From the upper-classmen 40 or 50 are selected each year for officers in the M. I. T. Cadet Regiment. These men are competent today, together with some hundreds of officers of past regiments, to undertake the drilling of recruits.

At a recent mass meeting of students a special committee of their own number presented a report advising the students that enlistment, in the ranks of an army, of men skilled in engineering would be an economic waste. The Technology students with their special training are fitted for more important work, and the advice of the committee was that under-classmen could better serve their country by remaining in the institute and perfecting themselves in those studies that would later make of them well-grounded engineers.

More than a year ago enthusiastic members of the instructing staff interested the upper-classmen and established an engineer corps (150 men). Map interpretation was taken up; the principles of reconnoissance and of fortifications and a deal of practical work were undertaken, like bridging real streams in military fashion. The United States Government has detailed an army officer for the instruction of this engineer corps and furnished equipment. What the alumni are doing has already become widely known. Today in a confidential file the Alumni Office possesses records of the abilities, past achievements and willingness to serve of about 5000 of the important engineers of this country, together with data that will make it evident where each man's talents may be made most useful.

A final word about the curriculum: Officers of the army have been commissioned to investigate. Their report has not yet been approved, but in outlines presented to the M. I. T. faculty it has been shown that, so far as engineering is concerned, the courses of the institute are almost precisely what an ideal military school would adopt. Something more of special military studies (it has been quoted informally as perhaps about 60 hours a year) should be added to make the institute instruction meet the military demands. J. RITCHIE, JR.

WORCESTER POLYTECHNIC INSTITUTE

The Worcester Polytechnic Institute has felt that the best preparation of its young men for service in case of war is to make sure of their thorough training in the manufacturing and other engineering duty that they would be called upon to do. It has been thought that purely military training without taking into consideration the special field that this school fills would lead to the same mistake that was made in England when many of the skilled mechanics and engineers were sent to the front.

Last fall, considerable attention was paid to organizing the work in the gymnasium in the direction of the exercises serving as preliminary to military drill and to organizing more effectively the Rifle Club already existing here. We have six target ranges in the gymnasium, where there is a great deal of practice.

This spring, the faculty has voted to permit students to devote some time to special preparation in subjects to which our attention has been called by the War Department. We propose to take time from the prescribed studies, in that way recognizing the emergency, by changing the requirements for the class that is to graduate in June. There will be some lectures from army officers, intended to inform our students more fully about the places for which they can volunteer in case of war. We already have openings for the bulk of the graduates, and these openings are of such a nature in connection with manufacturing for an army that the students ought not to go into the regular line. IRA N. HOLLIS,
President.

UNION UNIVERSITY

At the first assembly for drill, to which a general invitation to the whole body of college students was extended, nearly 300 students, including the members of the class in military engineering, reported for drill, and that number has been maintained.

In addition to this, Prof. E. J. Berg, of the electrical-engineering department, has organized a class for instruction in military wireless signaling. Prof. E. E. Hale has also organized a class in military-map making and reading. A machine-gun company has also been organized by students who have taken the Plattsburg training, and a Maxim machine gun has just arrived.

A number of students have been called out by their membership in the National Guard, and others have enlisted—four for the Aviation Corps and a considerably larger number for the Naval Reserve. A large number of senior students in the general-engineering department are making applications for examination for commissions in the United States Officers Reserve Corps.

The above are all temporary or emergency measures. As a permanent measure the college faculty, after careful consideration, has unanimously voted to recommend to the Board of Trustees of the college that, beginning with the college year in September, 1917, a United States Reserve Officers Training Corps of senior grade be established at the college.

The spirit of national patriotism in time of need, which in '61 made the college famous as a patriotic institution and which nearly depopulated it, is still alive and will insure that Union College and Union men will continue to serve the country in war as well as in peace.

OLIN H. LANDRETH,
Professor of Civil Engineering.

RENSSELAER POLYTECHNIC INSTITUTE

A large number of our graduates have already made application to the Chief of Engineers of the army, offering their services. We have made arrangements to take a census of graduates, as this may possibly be useful in order to enable us to give information to the Government, should such be desired.

We have made no effort to establish military training here, and I do not think we shall do so, since the establishment of such schools will tend, I believe, to defeat the efforts for universal military training under the national Government, which is what this country needs. In case of real war we should probably introduce courses in military engineering. PALMER G. RICKETTS.

COLUMBIA UNIVERSITY

President Nicholas Murray Butler will recommend to the trustees that officers of instruction who are members of the permanent staff and who volunteer or are called upon for public service be protected from loss of income, so far as the resources of the university will permit. Leave of absence will of course always be granted to any officer of instruction who enters the public service.

The president will recommend to the several faculties that all undergraduate and professional students who are in good standing on Apr. 2, 1917, and who wish or are required to withdraw from the university for public service be regarded as having satisfactorily completed the entire work of the academic year and be graduated or promoted accordingly.

A course in training for motor-boat patrol work is now being given in the engineering departments to 138 students.

The Committee on Instruction of the Faculty of Applied Science has also arranged for the substitution of

work in military preparation for some of the regular courses for the men who remain here until the end of the term. Of the instructing staff in the Schools of Mines, Engineering and Chemistry, a large number of men are enrolled for the Reserve Engineering Corps, and several of them are already being utilized by the Government for consultation work.

A general university organization is very active just now in providing for an Officers Training Corps and in offering opportunities for miltary instruction for both students and alumni.

GEORGE B. PEGRAM,
Acting Dean.

NEW YORK UNIVERSITY

The physics and chemical laboratories, with their officers of instruction, can be placed at the disposal of the Government at very short notice. Several dormitories are available for Red Cross work. A 40-acre campus also can be placed at the disposal of the Government.

The university unit of the Officers Training Corps has been organized. Already 299 men have enrolled. Drill commenced this week. It could not commence earlier, because we could not secure the proper officers; even now we are without guns. The training courses at the Brooklyn navy yard have attracted 54 men, all mechanical engineers, while 60 men have enlisted for two years, or the war, in the Red Cross.

Arrangements have been completed under which other men, members in the National Guard or others who may leave the university before the end of the present term for national service, will be released from university duties. All men listed as seniors will be graduated at once, and all men listed as juniors will be credited with having completed the junior year.

CHARLES H. SNOW,
Dean.

COLLEGE OF THE CITY OF NEW YORK

Five hundred young men are now taking a military course during the daytime, consisting of five hours a week of practical training, chiefly drill, and three hours a week of theoretical instruction. Thirty young men in our evening session wish this course to be repeated after business hours, and this will be done if the course obtains an additional enrollment of about 60. Any young man who resides in the City of New York and has graduated from college, or even completed the sophomore year in college, will be admitted to the course and will be under no expense. We are daily expecting the approval of this work by the War Department and assignment of an officer as professor of military science and tactics, to have charge of the course. Those who complete the course satisfactorily, which they probably can do by next September if they elect to take suitable summer-camp work, will be eligible for commissions in the Reserve Officers Corps.

S. E. MEZES,
President.

STEVENS INSTITUTE OF TECHNOLOGY

Our alumni have been decidedly active in connection with the several movements looking to coöperation on the part of engineers for national defense. The undergraduates have been given a number of lectures by prominent officers of the army and navy, and we are now endeavoring to shape our new department of physical education along the lines of preparedness.

With regard to students who may be called away from their studies, of course we will not be able to graduate them unless they complete their studies, but we shall do everything in our power to facilitate their work outside of regular roster hours.

ALEXANDER C. HUMPHREYS,
President.

PRINCETON UNIVERSITY

At present about 900 students out of a total enrollment of 1600 are taking military drill. The drill for each student comes on three alternating days of the week, either Monday, Wednesday and Friday or Tuesday, Thursday and Saturday, between 2 and 4 p.m. The regular work of the university has given way to the drill, partly I may say for the psychological effect upon the students, who have been naturally very much excited over the recent events. Some have already left to join the Mosquito Fleet at Newport, and a number of others have put in applications for service of various sorts. Probably the drill will continue throughout the summer, and arrangements may possibly be made to take men from other institutions that do not have the same military advantages that we do.

Many of the faculty have volunteered their services as advisers in many ways, and some are already doing valuable research work for the Government.

F. H. CONSTANT,
Professor of Civil Engineering.

UNIVERSITY OF ILLINOIS

Acting under the recent authorization of Congress for the establishment of various units in the Reserve Officers Training Corps in colleges and universities, the University of Illinois has been authorized to install an infantry unit, an engineering unit and a signal unit under the general supervision of five commissioned officers and seven noncommissioned officers of the United States Army.

The infantry unit consists of two complete regiments, each having 15 companies. The engineering unit is composed of one company, and the signal unit of one company. The total number of young men enrolled in these several organizations during the current year is 2229. This is one of the largest, if not the largest, group of young men under military instruction in any university in the country.

Battery F of the Illinois National Guard is also stationed at the university. The officers of this battery are members of the faculty, and it is composed almost entirely of students. This battery saw service on the border during the past summer, and it may be called out again at any time.

At a recent meeting, the Council of Administration of the university took action rendering it possible for students who may be ordered into service to continue their studies in camp and to take special examinations under the direction of their officers, so that university credit may be secured for certain courses in which these men may be enrolled.

About two months ago the president of the University of Illinois tendered to the governor of the state the use of the scientific laboratories and other facilities of the university to the state and nation in the event of war.

C. R. RICHARDS,
Acting Dean.

Powerful Drill-Car Effective in Uneven, Spongy Rock

Inclose 75 Acres of Mississippi River at Rock Island Rapids, Le Claire, Iowa, and Deepen New Canal with Steam Shovel

By J. B. BASSETT
United States Assistant Engineer, Rock Island, Ill.

On pumping out the 75-acre area inclosed in a box cofferdam of the record length of 8680 ft. for the upper portion of the new artificial channel through the Grand Island rapids of the Mississippi River, an uneven and spongy rock surface was disclosed which was attacked with satisfactory results only after two heavy drills had been removed from a drill boat and mounted on a flat car. The cofferdam, which incloses the upper half of the 4-mile channel that is to provide a 6-ft. waterway from St. Paul to St. Louis, is not only used in unwatering and excavating the channel, but will form part of a low-head dam to separate the channel from the rapids and maintain a navigable stage in the latter at times of low water in the river. The remainder of this dam is being built by a suction dredge, depositing a core of sand, and by dumping the rock removed with a steam shovel from the upper part of the channel. The general features of the

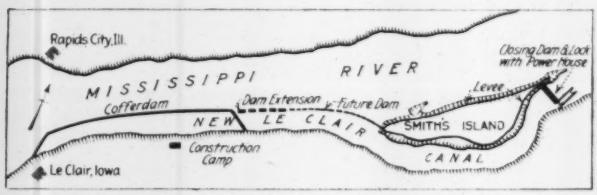


FIG. 1. UPPER PART OF CHANNEL UNWATERED FIRST

project, and the first season's work, including the construction camp and the building of the first cofferdam, were described in the *Engineering Record*, Dec. 25, 1915, p. 785.

Lock at Lower End Yet To Be Built

The Le Claire Canal, now being constructed along the upper 4 miles of the Rock Island Rapids in the Mississippi River, is on the Iowa side, and is to provide a 6-ft. channel at low water through this portion of the rapids and at the same time provide a slack-water channel that may be used in preference to the present existing tortuous channel of only 4-ft. depth. The project, approved in October, 1913, was estimated to cost $1,282,797.

The canal, 3½ miles long, will be formed by a longitudinal dike or wall beginning (about 300 ft. from shore) at the head of the rapids, just below Le Claire, and extending downstream roughly parallel to the shore to the head of Smith's Island. The island, leveed in low places, then serves as a dike. At the lower end the channel will terminate in a lock and a closing dam of puddled fill and riprap. For about 2 miles the dike will be built to the height of a 6½-ft. stage in the river at the head of the canal. Beyond this it will be raised above high water for the remainder of the distance to Smith's Island, about ½ mile. The upper portion will act as a spillway at stages above 6½ ft. and will be protected from erosion by a concrete apron. The levees on the island will be raised above high water. The construction plan contemplates the excavation of rock in the upper portion of the canal (about 2 miles) within the cofferdam, and the building of the longitudinal wall down to the head of Smith's Island. This will be followed by the construction of the 80 x 350-ft. lock and the closing dam and then the channel straightening at the lower end. The subsequent excavation of rock and sand in the approaches is to be done whenever plant is available and sufficient funds are on hand.

Pump and Suction Dredge Unwater Cofferdam

The unwatering of the enormous cofferdam is done by a motor-driven centrifugal pump assisted by a suction dredge. The latter is used only when the area has been flooded and assists in taking out the top 10 to 12 ft. of water only. The permanent plant is an 18-in. double-suction centrifugal pump directly connected to a 100-hp. motor running at 575 r.p.m. This operates on 440-volt three-phase 60-cycle current, purchased from an interurban railway. The pump and motor are on one bedplate placed on a raft. The discharge pipe has two flexible ball-and-socket joints and leads over the top of the coffer. At times of flood the bolts in the flexible joints are loosened and the raft floats to any height. It is held by the discharge pipe and by cables fastened to the coffer. The value of this scheme is that the pump is never submerged and the suction lift is small and uniform. In ordinary weather, pumping is done 6 to 7 hours per day.

A few of the itemized costs may be of interest. The cost of lumber (1,123,723 ft. b.m.), including unloading and storing, sawing, boring, loading on barges, towing to coffer and erection, was $41.59 per M b.m.; or $43.97, including a floating-plant charge. The cost of steel (319,244 lb.), including handling, storing, transporting and erecting, was 3.37c. per lb.; or 3.62c., including a floating-plant charge. The cost for cofferdam filling (100,013 cu.yd.) was 41.11c. per yd., distributed as follows:

District-office charge	$0.0047
Dredging	0603
Towing	0842
Unloading by derrick-boats and by hand and leveling	1158
Floating-plant charge	1461
Total for filling	$0.4111

Hand Drills Useless in Porous Rock

The drilling plant originally consisted of three portable gasoline-driven air compressors of 140-ft. capacity and a set of Jackhamers. The reasons for using the latter were that the depth of rock cutting to grade was at no place over 5 ft., and as the ledges were irregular and disconnected it was thought that a light flexible outfit would be more economical than a set of wagon drills, as first proposed.

Drilling with the Jackhamers started our troubles. The surface of the rock was so rough that the portable compressors could not be moved alongside the work except by very expensive blocking. All three compressors were therefore loaded upon a barge just outside the cofferdam, and the air pipe was led into the pit. The barge was moved along as required; and in spite of the fact that there was much cold weather, the swift current kept the ice from forming along the coffer. This arrangement worked very satisfactorily.

The nature of the rock was a surprise in spite of the knowledge from surveys that the surface was very

irregular. In appearance it is much like petrified sponge. It lies in masses with a slight surface appearance of stratification on edge, inclining about 45°. The cavities vary from very small to large holes, often containing yards of fireclay, gravel, sand, etc. The rock itself is very brittle, and a drilled hole is only a series of cavities.

At no time were we able to drill more than 40 ft. of holes per day with the Jackhamers, and usually the progress was much less. The trouble was due to the crumbling rock falling in and clogging the bit, so that it could not be withdrawn. Many holes were lost after being drilled, owing to the inability to clean them out.

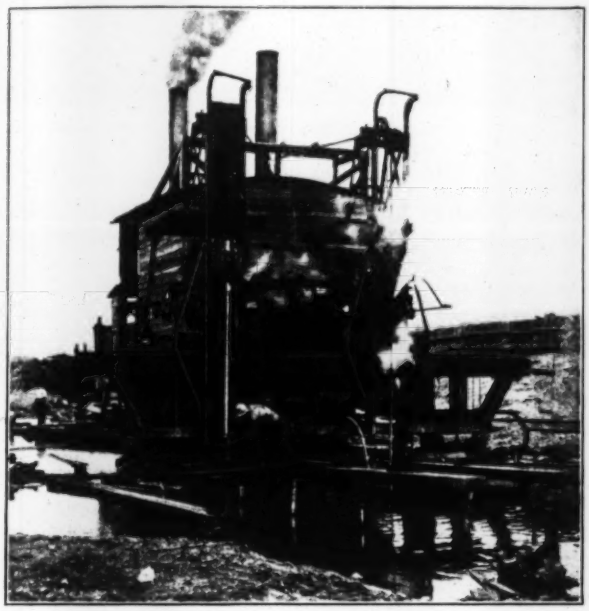


FIG. 2. IMPROVISED DRILLING CAR A SUCCESS FOR ROCK EXCAVATION IN LE CLAIRE CANAL

Air and water under pressure were tried, but most of the force was lost in the cavities in the rock.

In January, 1916, the cofferdam broke during a high river stage, and the work was temporarily discontinued. During the interval a drilling outfit was prepared which would have the power to overcome the difficulties encountered with the Jackhamers. Two drilling units, consisting of Ingersoll-Rand slab-back drills mounted on carriages with hoist engines, were taken from a recently built drill-boat and mounted on a 30-ft. runway built across the end of an ordinary railway flat-car. Boilers, pumps, water tank and coal bins were arranged, and the whole outfit was taken into the pit after the cofferdam had been repaired and the area pumped out. This machine is shown in Fig. 2.

The success of this drilling machine was demonstrated on the day it began operations. The drills are powerful, and the hoist engines attached can withdraw the bit easily in spite of the fragments of rock, gravel, etc., which fall into the hole. A wash line of ⅜-in. pipe is used continually in the hole with the bit and increases the penetration materially. The resultant hole is larger than is needed, but its size allows the use of a 1-in. wash pipe by the powder crew, enabling them to clean the hole thoroughly to receive the load.

The drill-car is run on track sections 10 ft. long, similar to steam-shovel track. The track is carried on blocking, which is rather heavy at times, owing to the uneven surface. Drilling and loading can continue without interruption through water holes that would stop an ordinary quarry outfit. Three crews are employed, working 8-hr. shifts, and the average penetration per drill-hour has been 13.7 ft. All delays of every description are included in drilling time. Actual penetration is of course much faster, 1 ft. per min. often being accomplished. This drilling record is not brilliant, nor is the operation particularly economical; but in view of the conditions encountered it is considered satisfactory.

Railroad Methods Build the Dike

The plant handling the broken rock consists of a 70-ton Bucyrus steam shovel, three Davenport 20-ton dinkey locomotives and an outfit of Western 12-yd. air-operated dump-cars. All tracks are standard gage, which permits connecting with the siding at the camp. The rock is dumped from the top of the cofferdam to form the permanent dike or dam. It is also used to extend the dam downstream to the head of Smith's Island. This portion of the dam is being constructed of waste rock with a sand core and will be used later as a cofferdam when the adjacent rock ledge is moved.

During the navigation season, when the floating plant was available, blasted rock from subaqueous excavation above the cofferdam was towed on barges to the lower end of the cofferdam and dumped in a ridge rising to the water surface on the line of the inner toe of the proposed dam. Sand secured by dipper dredge was placed alongside and against the rock ridge. The track on the cofferdam was then extended on the sand core, and rock from the shovel excavation was dumped from cars on the opposite side of the sand from the first rock ridge. By raising the sand ridge and by dumping rock from the shovel the dam can be brought to the desired lines.

Winter Work

Anticipating the time when the floating plant would not be available, and to avoid stopping this portion of the work during the winter, a storage pile of sand alongside the line of the proposed dam was pumped by a suction dredge from a bar at a distance in the river. The dredge was then moved to the storage pile, in a protected position, and allowed to freeze in for the winter, with the idea of furnishing sand for the sand core by pipe line.

The pilot rock ridge, originally deposited by floating plant, has been extended somewhat by arranging track on ordinary flat barges connected with the track on the dam. Trains from the shovel pit are run onto the barges and the cars dumped sidewise. When the desired amount of rock is deposited, the barges are moved forward, the track is extended on the rock fill, and connections are made for another setting. This use of the barges and cars has been fairly successful during the winter.

Major G. M. Hoffman, Corps of Engineers, U. S. A., is in charge of the district work. The writer is in charge of the Rock Island Rapids Division, with H. E. Reeves, Assistant Engineer, in local charge on the Le Claire Canal, and Otto Kuehlocke in local charge of floating plant.

Profit or Loss in Hauling Road-Building Material

A Discussion of the Relative Merits of Teams, Tractors, Motor Trucks and Industrial Railways

By A. D. THOMPSON
Contracting Engineer, Peoria, Ill.

FOUR general methods, each effective in its particular field, have been used for transporting road materials. These methods are: (1) Teams and wagons, (2) tractors and trailers, (3) motor trucks, (4) industrial railways.

Hauling with wagons drawn by horses has a very limited field of economic activity, but can be used under a great diversity of conditions. It is probably subject to the widest variations in cost of any of the methods.

If the materials are unloaded in the railroad yards of a city where there is much traffic, paved streets and many tracks to cross, haul by teams because of its flexibility of operation may well be considered.

If team haul is adopted, it is important to use only bottom-dump wagons. The old dump-board wagon, which requires 5 to 15 min. to dump, has been displaced by comparatively light two-horse wagons that can be dumped in motion and turned in a very short space on the grade, which prevents loss of time and makes possible a greater mileage per day.

Team Hauling Is Inelastic

The average speed of team travel with a load in one direction is generally estimated at 2½ mi. per hr. In a 10-hr. day this would total 25 mi., but with unavoidable delays and accidents, the daily travel under good conditions will not average above 20 mi. On steady work, 20 mi. is also the limit of capacity on this class of work of the average team, and during hot weather this capacity is reduced to 16 or 18 mi. per day.

A disadvantage in team haul is the lack of elasticity in the daily mileage limit, which cannot be increased an appreciable amount for a continued period without injury to the teams. Unless the round-trip distance is an even factor of the possible mileage per day, a considerable additional cost is involved through failure to secure service for the full working day. Suppose the haul limit per day is 22 mi., and length of haul 4, 6 or 8 mi. A sufficient number of loads cannot be hauled for efficient results, and the cost per ton is materially increased.

Tractors Require Special Wagons

The best steam tractors will haul 15 to 20 tons per trip on dirt roads. Many times trains are composed of horse wagons, but the small capacity of such wagons, difficulty in guiding and necessity of turning at each terminal make this method slow and wasteful, and only wagons built especially for this class of work should be used. These wagons are of the reversible, bottom-dump type, with steel wheels of large diameter and wide tires, and a capacity of 3 to 5 tons.

Another form of tractor, especially adapted for use in sand or mud, is the Holt "caterpillar," or the Phoenix "centipede." The rate of travel averages 2 mi. per hour with a consumption of about 4 gal. of gasoline per hour, with a load, and 3 gal. with empty train.

The cost of a contractor's caterpillar tractor is about $5500, and of the special tractor wagon with caterpillar wheels is about $1500 each. The manufacturers give the cost of operating a caterpillar hauling train as $18 to $22 per day, including fuel, oil, operator's pay, interest, depreciation and upkeep.

The use of motor trucks for hauling road materials has, until the past two years, been limited to the attempted adaptation for this purpose of the regular delivery or hauling truck used on city streets. Machines of this type, operated in single units, have not proved successful. It is only recently that manufacturers have appeared to appreciate the large field presented by road building, and to realize the necessity for machines especially designed to meet the strenuous and particular conditions imposed by this class of work.

Flexibility Gives Motor Truck Advantage

The rapid rate of travel, ease of operation, ability to perform many classes of work, adaptability to length of haul, flexibility of operation on city streets or in congested railroad yards, and ability to operate 24 hours per day when necessary, combine to create great possibilities for motor trucks and trailers as a large capacity, low cost system of hauling.

The type of truck generally used is gasoline-engine driven, 3- to 5-ton capacity, equipped with a dumping body. A side-dumping body is sometimes used, but the usual method is to dump the materials from the rear by elevating the front end with a hydraulic hoist. Rubber tires are used on the majority of makes, but at least two manufacturers are making trucks with wide steel tires for road work.

The use of wide steel tires is advantageous for operation over soft roads, and are less expensive than rubber tires. On macadam and gravel road work, these tires also have a compacting effect. A recent type of truck that gives promise of good results in road work is designed so the power is applied to the four wheels instead of the two rear ones, thus giving greater tractive power to the truck and considerable advantage in mud when one set of wheels is mired.

The rate of travel of 5-ton trucks, a size which appears to be in most favor, is from 8 to 12 mi. per hour, with about 10 mi. as the average when equipped with rubber tires. The steel tires do not absorb any of the load shock and trucks thus equipped cannot be operated fast. The average speed of trucks with steel tires is about 6 mi. per hour.

About 30 sec. is required to dump a load with the rear-dump type, and only a very rapid system of loading should be considered in operating this hauling method, as extra loading units are too expensive.

Trailers for Long Hauls and Light Grades

The efficiency of hauling with motor trucks may be materially increased, especially on long hauls, by the use of trailers when the conditions are favorable, as a truck has a hauling capacity greater that its carrying capacity. Generally good roads and light grades are necessary if trailers are used.

The cost of a 5-ton truck is about $5000, and the cost of operation varies considerably, but an average is from $18 to $22 per day, including interest and depreciation.

The amount of gasoline used varies with conditions, but a 5-ton truck with rubber tires will operate from 2 to 5 mi. on a gallon, while steel-tired trucks will get only from 1½ to 3 mi. per gallon.

A large amount of information on cost of truck hauling in cities has been published, but very little definite and reliable information is available on the practicability, reliability and cost of motor-truck hauling on large road contracts.

An advantage of considerable importance at times in the employment of trucks or tractors for hauling purposes is that they can be used for power to plow, pull road graders, or to operate elevating graders. One contractor in Iowa used his tractor to haul cars on an industrial railway.

The disadvantages of injury to grade, difficulty of turning and inability to operate during wet weather apply to both tractor and truck hauling.

The field of motor trucks has recently been invaded by the manufacturers of steam equipment. The Buffalo-Springfield Roller Co. has placed on the market a steam wagon similar in shape and style to the standard motor truck, but propelled by steam. This truck has steel wheels, chain drive, and will carry a load of six tons with power to haul a trailer of 3 or 4 tons at a speed of 3 to 7 mi. per hr.

Industrial Railways

The employment of industrial railways for transporting road materials is the logical application of a hauling system used for many years in mines, industrial plants and railroad construction. The track for these railways is usually 24-in. gage, with 16- or 20-lb. rails and steel or wood ties. The built-up track with steel ties is made in sections 15 ft. long, with five to seven ties per section. Two men can carry a section, which weighs about 270 lb. Lighter rails are sometimes advocated to lessen the initial expense, and if the cars are pulled by horses or other motive power operated off the track, a rail weight of 16 lb. may be used. With locomotive haul a 20-lb. rail should be the minimum considered, and a 25-lb. rail would result in a large saving of upkeep expense.

The hard service of road construction with locomotive power has brought out many weaknesses in cars that have been overcome only in the latest types. The old style cars were without end braces to strengthen the body supporting frame, and provided only a steel plate over the end of the frame for a bumper with a hole in it for a coupling pin, depending on the frame to resist the pulling strain, which resulted in numerous wrecked uprights and twisted frames.

Provision is now made for heavy springs in the couplings to absorb shocks with a continuous draw-bar to take the pulling strain from the frame, and rigid end braces for the body support.

The axles of the older type cars operated in roller bearings contained in boxes rigidly attached to the under side of the car frame. This rigid construction allowed for no adjustment for uneven track, and a small inequality would cause a wreck. The roller bearings are still used extensively, but they require daily oiling, and any neglect causes wear on the rollers that puts the car out of use.

These objections have been removed in the latest style cars by larger boxings with spring bearings, which allow an up-and-down play that is of great benefit on rough sections of track.

The successful operation of an industrial railway outfit requires the transportation of materials in large daily quantity, which can be furnished only by a most efficient unloading plant. To load the train in a minimum time, storage bins with a capacity of more than one train should be provided from which the cars can be loaded during the time the engine is taking coal and water, or a train of extra cars should be provided and loaded between trips.

In the construction of concrete roads, many contractors have adopted special mixers and dump the cars of properly proportioned materials directly into the loading skip. When this system is used, the hauling must be done in a limited time, and the daily progress of the finished work fixes definitely the amount of materials to be hauled per day, as hauling cannot be done when the mixer is not operated. This plan requires about 50% more equipment than if the material is dumped on the grade.

Provision should be made for a sufficient number of cars to operate each train with the maximum tonnage the locomotive can pull. Large trains are especially necessary on long hauls. On a track with not to exceed 2% grade, trains of thirty 1½-cu.yd. cars should be operated. One contractor the past season operated trains of 48 cars on one part of his work.

The investment necessary in an industrial railway equipment is heavier than for any other power hauling method. Outfits of track, cars and locomotives may be rented, but the character of the equipment and wearing nature of the work require a high basis for rental, and the price for one season is about 40% of the value in addition to freight two ways and heavy repairs after the return of the outfit.

Depreciation Cause of High Cost

The item of track maintenance is generally considered of trivial importance, but this becomes an expensive feature when operating in Illinois mud. When a track is left in place a sufficient period to lay 5 mi. of road, this expense should be figured not less than $50 per mile. Taking up track will also add $25 per mile for each time it is moved.

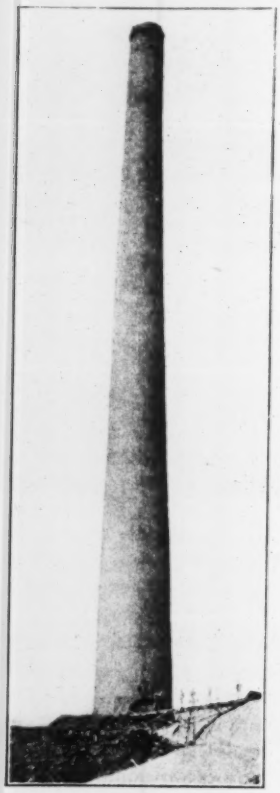
The estimated cost of operating per ton many times fails to consider delays from cars jumping track, slower speed because of wet grade, smaller trains at times because of cars out for repairs, lost time of train crews paid straight time, delays for taking on coal and water, and repairs to engine and cars. In fact, these numerous factors of lost time and additional expense will probably double the cost figures based on perfect conditions. Efficient management is probably more necessary for satisfactory results with this system than with any other hauling method.

The cost of transportation of road materials in Illinois by all methods has been generally underestimated by engineers and contractors through failure to properly appreciate the effect of unfavorable conditions. The influences affecting hauling costs are so numerous and uncertain, it appears the only safe method for estimating this feature of road work safely is to apply a rule laid down several years ago by an experienced contractor for figuring sewer work. Estimate the cost from the best information obtainable, double this result, and add 50%.

Concrete Chimney in Japan, Just Completed, Is Highest in World

Reinforced Structure for Smelter Plant Has Top 570 Feet Above Base—Designed To Resist Earthquake Shocks

THE highest chimney in the world is a reinforced-concrete chimney completed in January for a smelter plant at Saganoseki, Japan. It is 570 ft. high, 42 ft. 8 in. outside diameter at the bottom and 26 ft. 3 in. inside diameter at the top, with a thickness of 29½ in. at the bottom and 7 in. at the top. It was designed and built by the Weber Chimney Co., of Chicago, for the Oriental Compressol Co., of Japan, which has the general contract for the entire plant. The design includes provision for earthquake stresses and was checked and approved at the Imperial University of Tokyo. The foundation is a huge block of monolithic concrete in the form of a truncated cone 17 ft. high, 95 ft. diameter on the base and 42 ft. at the top. The center portion of the top is concave, with a bottom thickness of 7 ft. This foundation contains 2711 cu.yd. of concrete and required 30 days' work, day and night, for its construction. The pressure on the base is about 6000 lb. per sq.ft., including allowance for wind pressure. The steel reinforcement in the foundation and chimney amounts to 530 tons and consists of plain round and square bars of American make, purchased in Japan. In the lower portion of the chimney there are pairs of rings of ⅜-in. square bars spaced 6 in. c. to c. vertically; at the upper portion there are single ⅝-in. rings spaced 7½ in. c. to c. One 5-ft. course at the base of the chimney contains as much concrete as would make a 6-ft. chimney 120 ft. high.



HIGHEST CHIMNEY IN THE WORLD

The lightning-rod protection is quite extensive. At the top is a copper circle with seven platinum points extending 4 ft. above the edge of the chimney. From this circle seven cables lead down the chimney. At a height of 400 ft. from the base is another copper circle, or circuit, with four platinum points, and from it four rods lead down to the base.

The concrete is made with Japanese portland cement of good quality. For the chimney the mix is 1:2½:4, using 1-in. stone. For the foundation the mix is 1:3:5, with 2-in. stone. The chimney was built in courses 5 ft. high. Two sets of movable forms were used, which allowed for leaving the forms in place 24 hours after the concrete was poured.

A 1-yd. Smith mixer was used, and a steam hoist [illegible] an elevator bucket in a wood tower built up inside the chimney. The Japanese authorities at first insisted that a complete outside scaffolding must be built, in accordance with local practice, but they were finally convinced that the other method was practicable. This effected an enormous saving in timber for the construction. There were eight Americans in charge of the work. Native labor was employed and was found to be cheap, but inefficient. All material was delivered by an aërial wire tramway 5000 ft. long.

Smoke Flue Baffled

The chimney is on a hill about 430 ft. above sea level, the ground having a steep slope to the water. The smelter is on the water front, as all transportation is by water, there being no railway. The distance is 2500 ft., and a reinforced-concrete smoke flue extends from the smelter to the chimney. The latter is of elliptical section, 30 ft. larger diameter, with a wall 8 in. thick. It is built on a zigzag line, so as to form a series of baffles to check the flow of gas and cause the dust to settle. A manhole and interior stairway provide access for collecting and removing the dust. The lower part of this flume is built in a trench cut to the required shape. At the base of the chimney is an opening 20 ft. wide and 31½ ft. high, from which a horizontal conduit 29 ft. long is built integrally with the chimney. The smoke flue is connected to this. The bottom of the opening is level with the top of the foundation.

Concrete Cantilever Bridge with Suspended Span

That reinforced-concrete construction is progressing steadily toward the intricacy of steel bridgework is illustrated anew by a bridge of original type built in Switzerland a few months ago. It spans only 47½ ft., yet it is of full cantilever type, having an anchor arm on each side, 10½ ft. long, and a suspended span 26½ ft. long. Shouldered ends of the suspended span rest on shelf-like projections of the anchor arms.

The under side of the bridge is shaped to a flat-arch curve, with 37-in. rise, and to carry out this effect more fully the vertical joints at the ends of the suspended span are covered by heavy vertical beads extending up to the top of the balustrade.

There were several reasons for using the cantilever type of construction: Bad bottom, which made arch thrust undesirable, and restricted height, which demanded a shallow floor, were the chief ones. The relation of required waterway and street grade limited the total depth at midspan to 36 in., and the net depth (below paving) to 24 in.

The reinforcement is noteworthy for its use of hooping in the top-flange compression zone of the suspended span and at both upper and lower bearing seats. The main reinforcing bars are largely bent up and have semicircular hooked ends. The bridge has six longitudinal ribs on its 33-ft. width (of which 8 ft. is footwalk, on one side only). Transverse floor-beams occur at about 8-ft. intervals. The structure was designed for a 36-ton truck and a 36-ton roller (one-third of these figures represents impact allowance).

The abutments are founded on piles, proportioned for 12 tons maximum loading after assigning 1 ton per sq.ft. bearing to the ground. The rear row of piles is designed to take tension, the maximum live-load condition giving 6 tons tension per pile in this row.

The bridge crosses the Glatt River at Dübendörf. It replaces an iron bridge built in 1887. The designers were Terner & Chopard, and the contractors Fietz & Leuthold, both of Zürich. The *Schweizerische Bauzeitung* of Feb. 3, 1917, gives drawings and data.

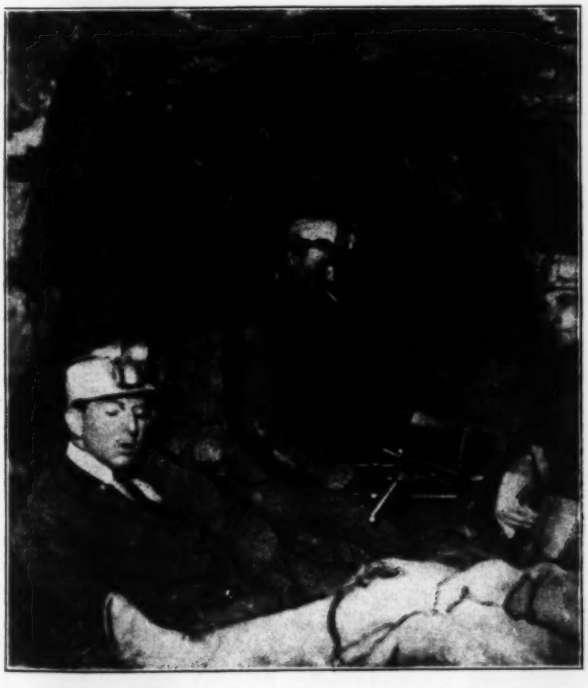
One-Man-per-Heading Tunnel Driven Through Shale

Internal Diameter of Bore for Sewer in Des Moines Measures Only Thirty-Six Inches

A SEWER tunnel 3117 ft. long, lined with vitrified-clay segmental blocks to an interior diameter of 36 in., is a feature of the Close's Creek sewer system at Des Moines, Iowa. This system comprises 23¼ miles of 10-in. to 36-in. sewer. Pipe is used for all sizes up to 24 in. The tunnel is in hard shale rock that disintegrates on exposure. It is 50 to 60 ft. below the surface. Shafts for manholes were sunk at intervals of 300 ft. and headings driven in both directions from each shaft.

One Man per Heading

The excavation was sublet to miners, who use coal miners' hand drills as a rule. There is one man to each heading, and he loads his own car and runs it to and from the shaft. The cars are of wood, with a capacity of 8 cu.ft., and run on a track of 24-in. gage. The price for excavation is $1.75 per ft., the contractor supplying the dynamite and installing the shaft hoists. No cages are used, the cars being hitched to chain slings. The muck is dumped into wagons for removal. Some gas was encountered, and men were overcome at times, owing to lack of ventilation. No explosions occurred. There was very little water. The progress averages 2 ft. per heading per 9-hr. day, with six to eight headings under way most of the time.



ONLY ONE MAN AT A TIME COULD WORK THE HEADING FOR THE 36-IN. SEWER TUNNEL IN SHALE ROCK

Tile-Block Lining

The bottom of the excavation is dressed to shape for the tile lining. There is no concrete base, but where necessary a base of tamped shale or gravel is used. The loose material is shoveled in as backfill around and above the arch. The blocks are of the single-course type in lengths of 24 in., manufactured by the Dickey Clay Manufacturing Co., of Kansas City, Missouri.

In order to keep the tunnel within the limits of a winding street, it was necessary to make numerous angles in the line. To secure a greater velocity for a given fall and at the same time to shorten the line, these angles were replaced by curves of 212- to 4500-ft. radius. Manholes were placed at the P. C. and P. T. of each curve.

Elevations were carried below by measuring directly down the shaft with a steel tape from a point of known elevation above to a point below. The center line was projected below by suspending heavy plumb bobs on each side of the shaft, swung in muddy water or oil. Points in the roof marked the line below. They consisted of small-head finishing nails driven in wooden plugs flush with the surface. A ⅜-in. Star churn drill was used to drill the holes. Where the alignment was straight, the points, or sights, were set in pairs 2 ft. apart at intervals of 30 ft. On curves a pair was set every 10 feet.

How Alignment Was Carried

The miners obtained their alignment for drilling by suspending a line on each nail of the nearest pair and lining in with their lights. An inverted rod reading was taken on each nail head, and the distance to the flow line was marked on a tag tied to the nail. A large Buff & Buff engineer's transit with a specially constructed 20-in. tripod was used exclusively in the fieldwork.

In approaching one end of the tunnel the sewer is carried across low ground for about 125 ft. in a reinforced-concrete cradle. This is 5 ft. deep and 4½ ft. wide, with flat sides and bottom and semicircular top, and is supported on concrete piers 18 ft. c. to c. Inside this cradle is the 36-in. tile-block sewer. Beyond this, the sewer was built in opencut to the tunnel.

The contractor for the sewer system is the J. B. Sheets Co., of Pittsburgh, Penn. The work is under the direction of Karl Kastberg, City Engineer, and D. E. Thomas, Assistant City Engineer; J. M. Tippee is engineer in charge of construction. The work will be completed this spring. The cost of the finished tunnel, including manholes, is $9.35 per foot.

Strength Tests of Timbers Continued

The Forest Service has made 11,600 strength tests of timber during the past year, and now has on its record a total of 137,000 such tests. The data cover practically all American woods; at least those of commercial importance. The work of the past year was on 25 species.

THE ENGINEER IN FIELD AND OFFICE

A Department Devoted to Details of the Day's Work

Can We Agree on a Standard Notation for Beam Flexure?

By R. FLEMING
American Bridge Co., New York City

IN HIS "Stresses in Structures," Heller says that the student should be as familiar with the application of the formula for beam flexure as with the use of the multiplication table. Because this formula is one of the most important in the whole subject of stresses, a standard system of notation is desirable.

Sixty years ago Rankine gave in his "Applied Mechanics" the fundamental equation, $M = pI/y$. Later writers have departed from the notation of Rankine. A few present-day notations will be quoted.

TEXTBOOKS		STEEL-MILL HANDBOOKS	
Church	$M = \frac{pI}{e}$	Bethlehem	$m = \frac{fI}{n} = fS$
Heller	$M = \frac{sI}{y}$	Cambria	$M = \frac{pI}{X_1} = pS$
Kent	$M = \frac{SI}{c}$	Carnegie	$M = \frac{fI}{n} = fS$
Ketchum	$M = \frac{fI}{c}$	Jones & Laughlin	$Mr = \frac{fI}{n} = fS$
Lanza	$M = \frac{pI}{y}$	Lackawanna	$M = \frac{PI}{C_1} = PS$
Merriman	$M = \frac{SI}{c}$		
Trautwine	$M = \frac{SI}{T}$		

It is true that variance in notation causes little trouble to engineers making constant use of the equations, but to those who use them only occasionally it is a cause of annoyance. The writer suggests the following as a standard notation:

A STANDARD NOTATION FOR BEAM FLEXURE

b	= Width of beam, in inches
d	= Depth of beam, in inches
Section	= Section cut by plane perpendicular to longitudinal axis of beam
A	= Area of section, in square inches
c	= Distance from the neutral axis to the extreme fiber of section, in inches
I	= Moment of inertia of section about neutral axis, in inches to the fourth power
Iv	= Moment of inertia of section about axis parallel to neutral axis, in inches to the fourth power
v	= Distance between these axes, in inches
r	= Radius of gyration about neutral axis, in inches
L	= Length of span, in feet
l	= Length of span, in inches
W	= Total load uniformly distributed, in pounds
w	= Uniform load per foot of length, in pounds
P	= Load concentrated at any point, in pounds
M	= Total bending moment at any section, in inch-pounds
f	= Stress, in extreme fiber of section in pounds per square inch
S	= Section modulus, in inches to the third power
E	= Modulus of elasticity, in pounds per square inch (steel = 29,000,000)
D	= Maximum deflection, in inches
X-X, Y-Y	= Axes of coördinates
x, y	= Distances of any point from axes of coördinates, in inches

General formulas: $Iv = I + Av^2$; $I = Ar^2$; $S = \frac{I}{c}$; $M = fS = \frac{fI}{c}$

The letter n is universally used for the elasticity ratio between steel and concrete, or $E_s \div E_c$. For this reason the letter c is used in the above notation for the distance from the neutral axis to the extreme fiber of section.

Sewer Fractured by Backfilling

SPLITTING a brick-arch sewer longitudinally by unbalanced pressure of backfilling occurred in the construction of one of the intercepting sewers at Chicago. The sewer has a 7 x 7-ft. horseshoe section and is of brick except for a concrete-slab base. The cut was 15 to 18 ft. deep. The backfilling was done largely with cinders and earth, brought in by rail and unloaded from a track laid near the edge of the cut. This material was shoveled and spread by hand, in order to carry up the fill uniformly on both sides of the cut.

Once, however, several carloads of heavy clay were dumped in wet weather following a very heavy rain (when the shoveling gang had stopped work). With the load all on one side, increased by the weight of the locomotive at the top of the cut (on soft sliding ground), the unbalanced pressure was such as to fracture the brick arch along one side for a distance of about 150 ft., and a crack extended 150 ft. beyond this break. The fracture extended partly through the bricks and did not follow the cement joints.

Deeds Often Fail To Define Angles in Streets Properly

By PERRY K. MILLER
Montclair, N. J.

TOO brief descriptions in deeds often fail properly to define angles in streets. Taken in conjunction with the monuments found on the ground, they may result in unintentionally peculiar street shapes.

Observation of the fences in residential sections shows that a large percentage of the angles in streets have

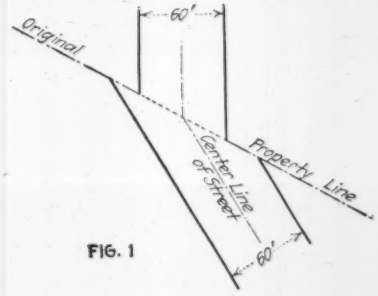


FIG. 1

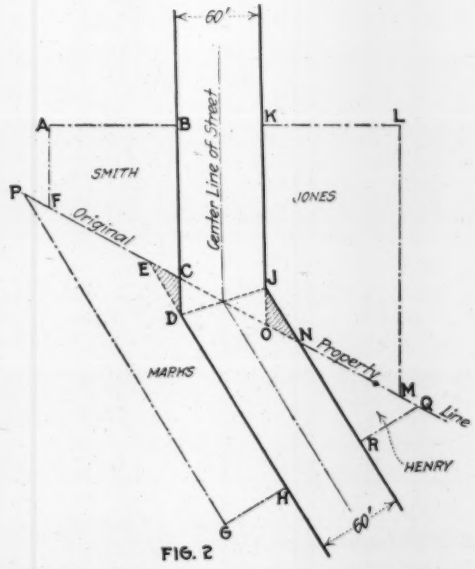


FIG. 2

ANGLES INCORRECTLY AND CORRECTLY DEFINED

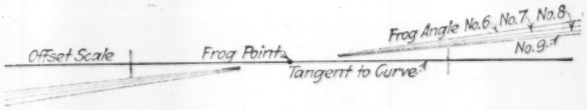
been located for convenience at points where the center lines cross property lines. When the owners of the abutting property dedicate land for the street, they are likely to give a strip so wide from the center line. The result is such a street shape as is shown in Fig. 1.

Fig. 2 suggests the remedy. The deeds bound the property of Smith, Jones, Marks and Henry by the lines *BCFA*, *KLMO*, *PEHJ* and *QRN* respectively. One more course is needed for the properties of Jones and Marks, so that they will be defined by the lines *KLMNJ* and *PCDHG* respectively. Only when *O* coincides with *J* and *N*, and *C* with *E* and *D*—that is, when the original property line bisects the obtuse angle between the center lines—is the difficulty automatically eliminated.

Templet Facilitates Laying Out Crossovers Between Curved Tracks

By C. D. NORTON
Sudbury, Ontario

CROSSOVERS between non-parallel curved tracks can hardly be located by any exact mathematical formula. Cut-and-try methods on paper on a large scale are the main recourse; but it is very difficult to lay out the flat curves without resort to geometrical construction,



TEMPLET AIDS IN PAPER LOCATIONS OF TURNOUTS

the lines of which would cover the paper if many trials were made. A transparent templet like that shown can be used to advantage. The base line can be set tangent to the curve by the offsets, the circle being placed at the desired frog point, and the line of the frog can be laid or pricked off. Thus a number of trials can be made without confusing the drawing by any considerable number of lines.

Dams of Boulder-Filled Wire Baskets Built in California

HYDRAULIC mining operations are now permitted in Western states only when there is some means of preventing the earth and rocks washed down by the jet from continuing on into the lower reaches of the stream. One way of accomplishing this is to build a dam across the stream just below the point where operations are under way. By this means there is formed a pool that serves the double purpose of providing a settling basin and capacity for storing the débris.

The margin of profit in such mining work is low; and where débris is to be retained by artificial pondage, only a dam that can be built at very low cost is feasible. Two dams have been built in California to meet this requirement. They consist of units, or baskets, of poultry netting filled with coarse gravel and rock. These units are 1 x 2 x 8 ft. in size and are placed lengthwise with the stream. They are built in place and are laid in the same way that shingles are placed on a roof, except that they are level instead of sloping. Each unit is made to lap over half of the preceding course.

As each course or layer is completed, sufficient backfilling is put in behind on the upstream side to give the structure a top width of 10 ft., in addition to the courses of netted units. The upstream side of the fill is kept at a slope of 1½ to 1, and the downstream slope ranges from 2 to 1 down to 1 to 1.

In making the units, common netting of 14-gage wire in 6-ft. widths is used. A 10-ft. length of this wire is cut from the roll and put in its place on the dam in a form composed of the last completed basket and a 2-in. plank set on edge and held in place by pins. Into the netting are then poured very coarse gravel and rock up to the size of a man's head. When a sufficient quantity has been deposited, the top is leveled off with a straightedge, and the selvage edges of the netting are drawn together by means of a piece of strap iron with a hooked end. The selvage edges are then fastened together with wire, and the ends are folded in and similarly fastened.

Construction Costs

On one of the dams of this type constructed for the Omega mine on Scotchman's Creek, California, the crew consisted of six men. Two men handled the netting, and four men shoveled and wheeled the material. This crew laid 20 baskets per day, a total of 320 cu.ft. They also placed the backfilling for this number of baskets, which brought up to 56.3 cu.yd. per day the total amount of material handled. At the rate of $3 per day per man the cost of labor and material in the entire dam was 48c. per cubic yard.

It is to be noticed that this work requires practically no equipment, calls for no initial investment in plant, requires no skilled labor and, aside from inspection by state officials, only such supervision as a foreman can give. The only construction material that has to be shipped in is the netting.

The material placed in the baskets is the coarsest obtainable. The backfill is made of finer material; and as the dam increases in height and the upstream face is continually extended, effort is made to use finer and finer material so that the seal will eventually be complete and the upstream face of the dam as nearly water-tight as possible.

The fact that the downstream slope is made of very coarse material permits seepage to escape promptly, and

THE GRAVEL-FILLED WIRE-BASKET UNITS ARE LAID LIKE SHINGLES ON A ROOF

thus internal pressures cannot be set up. Another feature peculiar to this type of construction is that the height of the dam need not be predetermined, and the structure can be continued indefinitely so far as the design and material are concerned. The first courses will be of the same design and size, regardless of the height of the dam.

Best Site at Stream Bend

Although the downstream face constitutes a cataract form of spillway over which the stream can quite safely be allowed to flow, thus far the plan has always been to provide for a spillway separate from the dam, when no further increase in its height is desired. This has been accomplished most conveniently by choosing a site for the dam where the stream makes a sharp turn around a rock promontory. The idea is that on completion of the dam a permanent spillway can be cut through the rocky point.

Location in such a position as this requires that the plan of the dam be fan shaped; that is, the exposed width of courses increases with the distance from the promontory around which the dam curves. To avoid unduly increasing the downstream slope near the promontory, it has been customary to adopt several centers from which the radial course lines will turn successively. These, however, can be laid out in a very simple manner after a location survey has been made, and the plan is easily followed by the construction foreman.

The idea from which these dams resulted was developed by J. M. Howells, consulting engineer, San Francisco, Calif., to whom it was suggested by the "Jakago," or levee facing made of bamboo and rock, used by the Japanese.

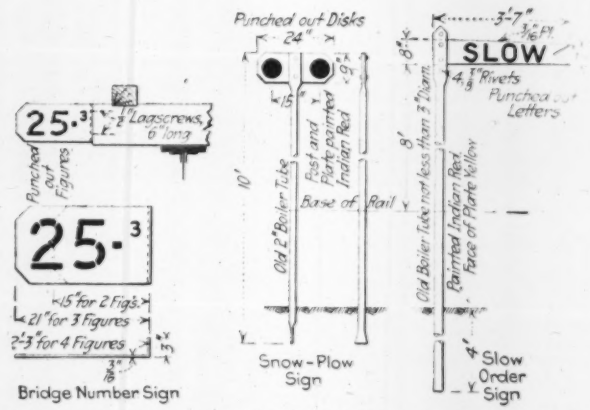
The first dam of this type on the Pacific Coast was begun for the Omega mine in 1913 and has since been raised by slow stages as the needs of the mine required. It now has 43 layers and is about 43 ft. high. This dam is founded upon an old concrete dam about 50 ft. in height, the cost of enlarging which by the addition of more concrete was prohibitive. The second dam of the basket type is being built on Nelson Creek in Plumas County and has now attained a height of about 26 feet.

Punched-Out Metal Signs Save Cost of Painting

SHEET-IRON signs with the inscriptions punched out are being introduced by the Canadian Pacific Ry. to eliminate the cost of periodical painting and lettering. Such signs require nothing but a coat of paint at long intervals, and no painting of letters or numbers. Their use was described by J. W. Orrock, principal assistant engineer of the Canadian Pacific, in Bulletin 192 of the American Railway Engineering Association, as an appendix to the report of the Committee on Signs, Fences and Crossings.

The bridge-number sign, a $\frac{3}{16}$-in. plate, attached to the end of a tie by lagscrews, costs from 75c. to $1. Mile-number signs are similar plates secured to telegraph poles. Such signs, Mr. Orrock states, should last about 50 years. A wood sign costing $1.25 will last 12 years and has to be painted and lettered every three years at a cost of 75c.; for a 48-year period its total cost becomes $17.

Snowplow and whistle signs are fixed on boiler-tube posts. Two 6-in. holes are punched in the target for the former sign and a "W" for the latter. Metal "stop" and "slow" signs cost $2.75 each.



TRACK SIGNS WITH FIGURES PERFORATED ARE USED BY CANADIAN PACIFIC RY.

The aforementioned committee recommends metal signs, with the post protected by being set in a concrete base. It suggests also the possibility of indicating the purpose of signs by their shape, without lettering, as has already been done by some roads to a limited extent.

Celebration Crowds on Bridges Represent Moderate Loading

THE assertion often made that some bridges get an early load test by inaugural-celebration crowds has been answered by claims that such gatherings represent at most only half-load. Evidence on the merit of such claims is found in the picture reproduced herewith, showing the lift span of the new Interstate bridge over the Columbia River at Portland, Ore., on the opening day.

This view shows a crowd that is perhaps as densely aggregated as would be likely at such a time. Almost the entire assemblage is standing in close order listening to the band. Yet, as the view shows, the crowd is loosely grouped, and the loading obviously is quite moderate, although a hasty look may give the impression of heavy loading. This case is in harmony with observations and measurements previously made, indicating that the weight of crowds on ordinary occasions is not likely to be far above 50 lb. per square foot.

LOOSELY GROUPED CROWD AT INAUGURAL CELEBRATION

EDITORIALS

War!

As the *Engineering News-Record* was going to press last week, the President delivered his war message before Congress. Since then, a state of war has been declared to exist and the United States stands side by side with England and France, Russia, Italy and Japan in the mighty conflict. No matter what the individual disagreements in the past with the President's policy, all now stand together in the assertion and maintenance of the nation's rights. If some believe that we have waited too long, that we carried patience to unwarranted limits, at least no one can contend that we entered the conflict precipitately or without just cause. The war has been forced upon us, but now that we are in it, we shall bend all our energies to the conflict. At this juncture, it behooves every citizen to consider his part in the struggle. Some will find their place in the fighting line; others in the administrative work essential for maintaining the effectiveness of the field forces; some in the industries, the third arm of defense, without whose support the fighting arm would be powerless; others will be able to help only by contributing from their incomes to the sinews of war. All, however, will have but one thought—that as a nation we have now only one purpose, the successful issue of the conflict. We look forward with confidence as to the ultimate outcome, with full realization that there is much suffering, many days of anxiety ahead, but with determination to make, uncomplainingly, whatever sacrifices are necessary. With justice on our side, we shall win.

The Country Responds

The week since President Wilson's great address to Congress was delivered will rank as one of the great epochs in American history. The spontaneous response from one end of the country to the other, from authorities of states and cities, from thousands of professional and social organizations, from business firms, from leading representatives of capital and labor has revealed the patriotic spirit of the nation as it has not been revealed since the outbreak of the Civil War. The depth of moral earnestness in this popular response is in itself an inspiration. Men everywhere are asking, not what profit or place can they gain from the Government, but what service can they render? In that spirit have come the free offers to the Government of manufacturing plants, laboratories, camp sites, hospitals, contracts for the sale of vast amounts of material at a financial sacrifice, agreements by labor organizations to declare a truce for the duration of the war and remove any restrictions on working hours that interfere with national defense. In all this splendid response from those who appreciate the great task and heavy sacrifice now before the nation, nothing quite so much grips the throat as the spirit of the boys in the colleges. We give space this week to the record of what a few of the leading engineering schools are doing in patriotic service; and it is typical of what is being done in many other schools. The patriotic readiness of engineers to render service has been made evident by the work for preparedness which a great number of engineers have been carrying on for the past year and more. Last week we printed the appeal of the Chief of Engineers for the prompt enlistment of regiments of engineer troops. This week we record the work already in progress by a committee of prominent engineers in New York City for the enlistment of a regiment here. New York's example should be and doubtless will be followed by a dozen other cities.

War Is Engineering

Every branch of the engineering profession will have its special duty to fulfill in the war that is upon us. War is now engineering—how often have we said it since August, 1914; how frequently backed the statement with a recital of the evidence! Transportation, signaling, aëronautics, at the front; ship and munitions manufacture, at the rear—all are engineering. Without intensive production in the munitions factories and, in fact, in all shops where supplies for the front are fabricated, the war could not go on. The men at the front must bear the brunt of battle, but the support at the rear is essential. If we had nothing but our confidence in the patriotism of American engineers to rely on, we would without hesitation predict their energetic participation wherever their services are needed. But the things already accomplished by engineers in the campaign for preparedness of the last two years, the leading part taken by engineers in this campaign, the patriotic response at the present time gives tangible evidence where the profession stands. The honor list when the war's heroes are posted will not be lacking its full quota from the engineering profession.

Technology Leads in Reform

For more than a decade, there has been active discussion among engineers concerning needed changes in methods of engineering education. This agitation crystallized some years ago in the creation of a joint committee, representing the national engineering societies, which was instructed to make recommendations as to needed improvements in engineering education. This committee eventually realized the impossibility that its busy members could devote the necessary time to the study of a subject which to a large degree required special expert knowledge. It, therefore, solicited and secured the support of the Carnegie Foundation for the Advancement of Teaching, and the Foundation placed the detail work of investigation in the hands of Prof. Charles R. Mann, of the University of Chicago. Professor Mann has completed this investigation, and his final report is soon to appear. The Massachusetts Institute of Technology has now secured his services to study and revise its own methods of instruction.

It will be recalled that Professor Mann, in his public addresses before engineering societies, has particularly emphasized the importance of character building—using that term in the broadest sense—in connection with educational work. The puzzling thing to many educators has been how to secure the practical results in this direction which all agree to be desirable. Professor Mann's work at Technology will be followed with great interest.

What Is Brake Load on a Bridge?

A PROMINENT bridge engineer offers the argument that the common allowance of 20% for tractive force on a bridge is excessive and leads to waste of metal. In many types of bridge the question is important. Braking forces mean extra metal and extra money. If the argument is correct that train brakes are proportioned for the empty weight, or a little less, and the friction coefficient probably never exceeds 20%, then it is clear that the static braking force will not exceed say 10% of the live-load for which the bridge is designed. If this is all, then the 20% allowance means spending twice as much money for braking resistance as common sense requires.

The decision turns entirely on the question of what effect is produced by the suddenness of brake action and the longitudinal vibrations that go through trains and perhaps through bridges in many cases of brake application. Briefly, braking impact must be considered. Bridges are so rigid longitudinally that the impact effect is not cushioned by the flexibility of the structure but retains its full value. Is it not reasonable to take a total braking allowance higher than the static brake effect, in order to make provision for impact?

Publicity Has Promoted Rail Safety

THE power of publicity reduced rail breakages by one-half in two years. Exact figures were reported during the past week at the meeting of the American Railway Engineering Association by the Rail Committee, which on this subject represents officially the organized lines of this country.

Among the rails rolled and laid in 1908, five years of service produced 398 rail breaks per 100 track-miles; of the rails rolled in 1909, only 278 breaks; of the 1910 rails only 198 breaks per 100 track-miles. Roughly, there were four breaks per track-mile in five years for the 1908 rails, and two breaks per track-mile in five years for the 1910 rails.

All the facts of the case are directly comparable; there can be no doubt that a 50% improvement was secured. A further reduction may be expected in the future, as a matter of natural advance.

We take pleasure in recording these figures. They represent the saving of many lives and a reduction of the world's ills. Figured out in hard statistical form, perhaps, the facts are not very impressive: They say that only 0.26% and 0.13% of all rails in service broke during one year. But these trifling percentages actually mean thousands of broken rails, thousands of chances every season for most disastrous wrecks. Reducing these chances one-half in two short years is a great achievement.

The improvement was brought about by publicity, and publicity alone. Today no one is able to say what makes rails break. There are many theories; the experts differ radically. In spite of study and research galore, chemical analyses and high-power microscope work, the causes of rail breakages yet remain obscure. But some years ago railway men and the public awakened suddenly to the fact that the situation was acute, that rail fractures were far too numerous. The bright light of publicity was projected upon this fact. The result is the 50% improvement just recorded.

State Regulation Will Not Cripple Municipally Owned Utilities

THE mismanagement of a large percentage of municipally owned utilities is a matter of common knowledge. It is usually borne with a degree of tolerance that is surprising in view of the storm of protest often directed against mismanaged utilities which are privately owned. To protect the patrons of private utilities, the latter have in recent years been placed under the more or less complete control of state utility commissions; but similar state control of municipally owned utilities is rare. In fact, Massachusetts and Wisconsin present the only notable instances of the kind.

When a bill for state control of municipally owned utilities was recently introduced in the Ohio legislature, word went out that the real object of the bill was to cripple municipal ownership. Whether that was really the moving force behind the bill, we cannot say; but why should a municipally owned utility be crippled by the same sort of state regulation as is applied to those which are privately owned? To cry out, "We shall be crippled," seems a confession of municipal weakness. No such crippling, but instead real benefit has resulted to publicly owned water-works in states where sanitary control of water-supplies has been exercised by state boards of health.

It is significant that the Ohio bill did not include water-works among the municipally owned utilities that were to be put under the State Utility Commission. This omission lends some color to the allegation that the bill was conceived in the interests of private lighting companies. At the same time it is to be noted that publicly owned water-works are so numerous in Ohio that there would be small chance for the passage of a bill that included them unless the cities themselves were willing to accept state control.

That Ohio's cities seriously need supervision of some sort from a competent state department is shown by the financial difficulties of many of them. Cincinnati, for instance, recently advertised a million-dollar loan of the cumulative-deficit financiering order. That is, it borrowed money last year to make up an operating deficit and then had to borrow again a larger sum to pay the debt with interest and more deficit. Toledo recently voted a loan to meet past current expenses, including back salaries of its own officials.

Unless the cities and villages of Ohio and of many other states reform their financial and some other of their administrative methods, their citizens should welcome a considerable measure of state administrative control both as regards city-owned utilities and city finances.

Scarce Labor

THE greatest difficulty that engineers have to face in planning work for the coming season is the condition of the labor market. For over a year past the demand for labor in all parts of the country has been increasing. Wages have steadily risen, and there has been a general tendency to decrease working hours, while at the same time there has been a falling off in efficiency.

This situation has been growing more acute during the past two months. In the shipbuilding industry, for ex-

ample, every skilled man available is being sought both for Government work and by private builders.

The manufacture of shells and other munitions for shipment abroad has almost ceased, yet the activity in nearly all lines of manufacture, in commerce and in transportation is so great that men enough cannot be found to fill the needs. With the issue of the bonds granting financial aid to the Allies, the manufacture of munitions for them on a large scale will doubtless be resumed. There is now to be added to this urgent demand the withdrawal of a large number of men for service in the army and navy. In a hundred industries that must furnish military supplies, everything possible must be done to speed up production. No more workmen can be drawn from the farming districts. On the contrary, in view of the urgent necessity of larger food production, means ought to be taken to bring labor back to the farms.

From sheer necessity there must result very material reductions in the amount of new construction work that can be carried on. In New York City the situation has become so acute that Mayor Mitchel recently appointed a board of city officials, including the leading engineers in the city service, to report as to which of the public works now under construction were most necessary and which could be postponed with the least public injury.

Sooner or later, the same problem must be faced and solved in other cities; and it is well to deal with it as promptly as possible. It is obvious that works on which construction has far advanced and which cannot be utilized until the remaining work is done are as a general rule the ones where the available labor and funds should be concentrated. On New York City's new subways over $150,000,000 has already been expended on which interest has to be paid. No revenue will be earned to meet this interest until some of the lines can be completed and put into service. It will be true economy, therefore, to complete such of the rapid-transit lines as are already far advanced, regardless of high prices for labor and material.

There is another important reason why cities and other public bodies may well delay as far as possible, at this time of scarce labor and high-priced materials, the construction of work on which delay is permissible. No one doubts that sooner or later the pendulum will swing in the other direction, and cities all over the country will be facing the serious problem of unemployment, just as they were only two years ago. All the work that can be delayed now and done when the next season of hard times comes around will be accomplished at far less cost to the taxpayer and will be a far better service to those who then lack employment than the establishment of soup kitchens and bread-line distribution.

The Engineer and Social Changes

THE late George S. Morison, one of the ablest engineers the United States has produced, put into final form in 1898 his essays on the "New Epoch." He pictured forcefully and in an inspiring way the change which the advent of the manufacture of power has had on the whole world. He showed how tremendous were the results of unlocking the stores of hidden energy. He made the engineer stand out in bold relief as the responsible, the pivotal figure in this mighty change.

Mr. Morison did not, however, take the final step and point out that the engineer, having inaugurated this era, is responsible not merely for the physical results of his work, but for the social changes that his work has caused. Possibly it was too early in 1898 to see this. Yet today it is crystal clear. In fact, the profession as a whole has been preparing itself with astonishing rapidity for the shouldering of this social responsibility. How else can we interpret its activities on public questions? How else the mobilization of the profession evidenced by the closer coöperation of the engineering societies?

We propose here to consider briefly the social responsibility of the engineer and to indicate how broad and inviting a future is his, if he is prepared to grasp it.

Industrial relations in this country are in a condition that may at any time precipitate a calamity. Witness the strikes of the last two years; the controversy between the railways and the trainmen, where a nation-wide tie-up of transportation has twice been narrowly escaped. These pressing problems grow out of the industrial conditions that engineers have created. The attempt of the man from the ranks—the business man, the financier, the lawyer—to handle them has failed miserably. They have bungled, and now the welfare worker and the social reformer are trying to right the wrongs, through philanthropy on the one hand and legislation on the other. They are having better success than the first group; yet the procedure is empirical and proceeds jerkily, with many failures to mark the way.

Fundamentally, what is the difficulty? Just this, that scientific methods have been applied to the study of materials and machines, but not to the handling of the human element in production. The machine development as a consequence ran ahead of the human and subordinated the latter. Men were fitted in to suit the machine; not the machine to suit the men.

As engineers we have been trying to get the greatest output or the best structure, under a given set of conditions, at a minimum cost. No matter what the other objects, cost of production has been one of our primary concerns, whether the product was a bridge, a ton of ore or coal, or a locomotive. Three separate factors have entered into the total cost—materials, labor and overhead. As to materials we have made great progress. We can specify to the last iota a steel for a certain purpose.

As to the overhead, too, we have made progress, though not to the extent we have in materials. We do not hesitate, for example, to increase overhead by scrapping obsolete equipment when greater end economies will result.

But what do we know about the factors that influence labor cost? We know the effect of every element in steel. Do we know each and every factor that influences the efficiency of a human being? Do we know the character and extent of that influence under different conditions?

To answer those questions, let us see what England has learned in the last two years. Before the war she was, industrially, a defeated nation. She had neglected, among other things, the human factor; her handling of labor was atrocious. What has happened since? Many of the experienced workers went to the war and were replaced by women who had never seen the inside of a shop. Yet today England is keeping up her export trade to five-sixths of the normal and at the same time is pro-

ducing prodigious quantities of munitions. And this is being done without impairing the health of the workers, even though the women on many jobs are turning out double the production of their experienced male predecessors.

This result has been secured by investigating many, if not all, of the factors that influence the efficiency of labor—not only the condition of the machines, the heating, lighting, ventilation and sanitary conditions of the factories, the hours of labor per day and the days of labor per week, but all the personal and home factors that might possibly have a bearing. What effect have insufficiency, poor quality and improper character of food? What effect the sanitary condition of the home? What is the relation between wages on the one hand and food and housing on the other? These are the questions that have been asked. Scientific methods of investigation (engineering methods, if you will) have been applied to the labor problem.

Does not this citation of England's experience answer the questions about our knowledge of labor costs and point the way to what we must do? Without a doubt we, too, must come to a scientific study of our industrial relations. True, our aim is not solely to secure large output. Contentment, social justice for the worker, is what we seek. But so does England. How else could the war be supported? It would take an army at home to keep men and women at work if they were dissatisfied. Germany solved the problem years ago of securing contentment for her workers; when war came, even the most radical elements entered whole-heartedly into the conflict.

Why has welfare work in this country so frequently failed of its objects—the development of contentment and a greater loyalty to the employer? Simply because it has not been scientifically studied and adapted to conditions in the given plant. It has been applied empirically. Any engineer could have predicted a goodly percentage of failures.

Elsewhere in this issue Miss Frances Kellor, whose successful work in the promotion of better conditions for labor is widely known, analyzes with keen insight the present conditions and the outlook for so-called welfare work, appeals for its organization on a practical scientific business basis and declares that the permanent solution for this problem lies with the trained engineer.

Need more be said to show that it is the engineer who must work out the solution of our industrial-relations problem? He brought into being the material environment that is responsible for the conditions under which labor is employed; he must adapt the two factors—human and material—to each other, that the human may not be submerged. Such studies of the human element, where made widely, are bound to crystallize into laws, with the result that the engineer will have a far-reaching influence on our future social structure.

But he must not be content with merely formulating the technical basis for the enactments. He must participate actively in the writing of the laws, in devising the machinery for their enforcement, in supervising their administration. They must be built on an engineering basis and, like any complex engineering structure, will need the constant application of engineering principles and knowledge for their proper operation.

But this is not the only direction in which the engineer's influence will be felt. The industrial structures that have been reared on his work are in an anomalous position. In the '80's and '90's, when the evils of unrestrained competition first showed up strongly, consolidation began on a large scale. Scientifically analyzed, the big-corporation idea is sound. The misdeeds of some corporations aroused public antagonism, and an era of trust-busting followed. But trust-busting is on a par with any efforts to impede the general progress. Temporarily there is a halt, followed by the overwhelming of the opposition. Some way will be found to allow consolidation and coöperation on a grand scale—with the concomitant specialization of plants, territorial agreements and price fixing. When this day comes, a new analysis will be needed of industry, in order that plants may be limited to what, considering raw material and labor supplies, they can most economically produce. Transportation, since regulated coöperation will have succeeded competition, will need to be studied on a new basis. Dozens of other problems will press for solution. Engineering activities will be much expanded, for efficient plans of coördination must necessarily be based on engineering analysis. Again, the practices will crystallize into law; the law will have an engineering basis and will need constant engineering knowledge for its administration.

This, then, is the great future that we see before the engineer, an opportunity, by solving the human problems that his material discoveries have created, to take a leading part in shaping the social fabric of the future. If he fails to accept the opportunity, if he passes to the politician and the welfare worker the task of securing the right answer, he will generate into a mere technician.

We believe that the larger and not the prosaic place will be his. The colleges are beginning to see the problem in a broad way. In their hands lies our professional future. If they paint the vision in proper proportions, if they impress on engineering students a feeling of responsibility for the social conditions that engineering discoveries impose, if they inspire the students with the desire to discharge, with deep human sympathy, this responsibility—if, above all, they train our young men to have the vision, the ability and the courage to play this larger part, engineers will be found in the forefront of America's future leaders. They will have grasped their opportunity.

United States Should Now Finance Belgian Relief

IN RESPONSE to the stirring appeal of President Wilson and the all but unanimous declaration by Congress, the people of the United States are ready to fulfill their international duties. In a military way the country is far from being prepared, and its navy lacks much of the personnel and equipment needed to meet present demands. In one direction, however, the United States is prepared as no nation ever was prepared before. It is able today to meet any financial obligation that may be placed upon it. The total resources of the national banks of the United States alone, as reported on the last call of the controller of the Treasury, are about 16 billion dollars; and there are besides the great resources of trust companies, savings banks, and other financial institutions.

There is one international task, in which American engineers have an especial interest, which it is the plain duty of the United States Government to undertake. We refer to the great task of feeding the people of Belgium and northern France. American engineers have an especial interest in this work because it was organized and has been carried out with wonderful efficiency and success by Herbert C. Hoover, an American engineer of whose achievements every citizen of the United States may well be proud.

It is owing to Mr. Hoover's ability as an organizer, as a diplomat, and as an inspiring leader of men that ten millions of people in Belgium and northern France have been saved from starvation. The work of the American Commission for Belgium Relief has hitherto been the one great and honorable accomplishment of the war which could be cited to defend America's reputation in Europe from the charge that our people were chiefly interested in the war because of the wealth they were reaping in supplying Europe's necessities.

Shortly after the outbreak of the war, when it became evident that the funds possible to be obtained through private charity would be wholly inadequate to save 10,000,000 people from starvation, Mr. Hoover went personally to the chief Government officials in each of these countries and pleaded the cause of the starving Belgians so eloquently and earnestly that these two nations, notwithstanding all the vast burdens they were themselves carrying, assumed in addition the responsibility of supplying about $14,000,000 a month to feed the people of Belgium.

Mr. Hoover's commission has expended over $250,000,000 in its work, of which all but about $40,000,000 has been contributed by the Allied Governments, and *only about $10,000,000 has been given by the people of the United States.* Further than this, most of the commission's purchases have been made in the United States, and there has been a war profit of at least $30,000,000 from the sale of these supplies.

In his remarkable address some weeks ago before the New York Chamber of Commerce Mr. Hoover said:

"Gentlemen—Europe has begun to take stock of us. We lay claim to idealism, a devotion to humanity, and to great benevolence. Time and time again when the door of Belgium threatened to close we have defended its portals by the assertion that this was an American enterprise, that the sensibilities of the American people would be outraged beyond measure, if its work were interfered with. Our moral strength has been based upon this assertion.

"It is up to our country to say whether or not this work—the greatest work which America has ever undertaken in the name of humanity—shall through its pretensions become a word of contempt. We have fought a good fight, we have tried to keep the lamp of humanity alight and to implant true Americanism in Europe. If we fail, it will be the failure of the American people."

Since Mr. Hoover made the address from which the foregoing is quoted, the situation has been radically altered through the declaration of war against Germany by the United States. The American people have been roused and united by President Wilson's magnificent summons to join hands with the Allies in the battle for democracy. The Allies are now fighting our battles and the President has declared that the financial power of the United States should be extended to their aid.

What more fitting beginning could there be to this extension of financial aid than the taking over by the United States of the burden of feeding Belgium? This nation is already receiving a credit which is not justly its due because the undertaking conceived and carried out by a great American engineer was put under the protection of the United States flag. This flag can no longer protect that work; but we as a nation can rightly earn the honor which has hitherto been given to us by taking over the financial responsibility for its maintenance.

American engineers have already shown their interest in this work by their contributions to the funds to carry it on. The mining engineers alone, which is the branch of the profession to which Mr. Hoover belongs, have raised $88,000 in response to Mr. Hoover's appeal for sufficient additional funds to prevent the school children of Belgium from breaking down in health under their scanty allowance. But the most effective way now in which engineers can support the magnificent work of their colleague is by a general appeal to Congress to undertake this financial responsibility at the earliest possible date. To such an expenditure of Government funds even the most pacifistic pacifist could surely raise not the slightest objection.

It should be explained furthermore that the contributions by the Allied Governments for the support of the people of Belgium have not been made as a gift, but as a loan. Large though the sum to be contributed may seem, it must be understood that the American commission, under Mr. Hoover, has accomplished the task of keeping the starving population of Belgium alive at an average expenditure of only seven cents a day per capita. Surely there could be no protest from any section or class in the United States against a loan by our Government to the people of this devastated nation of seven cents a day until the invader can be defeated and its population placed once more on a self-supporting basis. Mr. Hoover has done his part nobly for the honor of the American nation. It is up to this nation now to undertake its responsibility in maintaining that honor.

It is of great interest in this connection to record that Mr. Hoover, although since the outbreak of the war compelled to be a neutral of the neutrals, is in full accord with President Wilson's address to Congress on April 2. In a cabled message to President Wilson on April 3, Mr. Hoover said:

"The members of the American Commission for Relief in Belgium ask me to transmit to you an expression of united devotion and of our admiration for the courage and wisdom of your leadership. We wish to tell you that there is no word in your historic statement to Congress that does not find a response in all our hearts.

"For two and a half years we have been obliged to remain silent witnesses of the character of the forces dominating this war, but we are now at liberty to say that, although we break with great regret our association with many German individuals who have given sympathetic support to our work, yet your message enunciates our conviction, born of our intimate experience and contact, that there is no hope for democracy or liberalism, and consequently for the real peace and safety of our country, unless the system which brought the world into this unfathomable misery can be stamped out once for all."

"Engineering News-Record" Consolidation Elicits Comment from Members of Profession

Men in Various Positions and from All Parts of the Country Look Favorably on Merger of Two Papers

In addition to the letters of congratulation published in the April 5 issue of this journal the following have been received.

CHARLES D. MARX

Past President, American Society of Civil Engineers, Stanford University, Calif.

I wish to congratulate you on the consolidation of "Engineering News" with the "Engineering Record." I am sure that the engineering profession will agree with those who have brought about this merger that it was a very desirable thing to do. I wish you all possible success on entering on your larger responsibilities.

WM. L. SAUNDERS

Chairman, Ingersoll-Rand Co., President, U. S. Naval Consulting Board

That two such virile papers as the "News" and the "Record" should be consolidated under one management is a wholesome evidence of the fact that these journals recognize those fundamentals of engineering, which are efficiency and strength. I have regarded both the "News" and the "Record" as the most valuable engineering educational institutions outside of a university. When united, I am inclined to think that the influence will be greater than that of any university.

But these journals are more than educational. They contribute to business development through engineering; they are the arms of industry.

C. H. RUST

City Engineer and Water Commissioner, Victoria, B. C.

Upon looking at my back volumes, I note my subscription to "Engineering News" commenced in 1885, and to the "Engineering Record" in 1890. All these volumes have been bound and are in my library. I have kept a card index of the more important subjects appearing in these publications, more particularly those pertaining to the municipal branch of the profession. This information has been of inestimable value to me.

In the early days I considered it would be very difficult to improve the technical matters treated therein; but within recent years both papers have surpassed their earlier efforts, and I do not know of any large engineering work which has not been referred to, and nearly always a very full description given of the undertaking.

No doubt, at first, to many of the older members of the profession it will seem as if we had missed two old and valued friends, but I feel assured that the combined talent of the two papers will produce a technical journal of a very high order.

LEONARD C. WASON

President, Aberthaw Construction Co., Boston, Mass.

I wish to congratulate you upon the much enlarged field of usefulness before you, due to the consolidation of "Engineering News" and the "Engineering Record." Both papers have been indispensable to the contracting and professional engineer in the past, and the consolidated paper will be doubly useful.

To take an analogy from the building field, assume the subscriber and reader to be in the position of a person who is about to let a contract. If he lets the contract on competitive bids, he gets fair service; sometimes poor. If he lets it on a cost plus fixed sum basis, he gets co-operation among himself, contractor and engineer and gets thereby first-class service. Your consolidated paper is in the second class, and I, as a subscriber, look forward to much better service and better co-operation than in the past with either paper.

GEORGE G. EARL

General Superintendent, Sewerage and Water Board, New Orleans, La.

I am pleased for many reasons to know of the consolidation of "Engineering News" and the "Engineering Record." I have subscribed to the "News" continuously since about 1884 and to the "Record" since 1888. They have both been indispensable; but there has been more and more overlapping of the fields covered, and they have grown so large that binding and shelfroom were becoming an embarrassment. Combined, these embarrassments and duplication will cease and we will have what we really need, an engineering weekly more than national in its scope, which cannot fail to command the support of all engineers.

W. S. GEARHART

State Engineer of Kansas

I have been reading "Engineering News" and the "Engineering Record" regularly for the past 13 years. These journals have done much to establish the engineering profession in the confidence of the public, to give it proper public recognition and to bring the engineer to a realization of his opportunities for public service. They have also accomplished a great deal in standardizing engineering construction and in establishing good engineering practice.

With the combined forces of both journals, "Engineering News-Record" will lead the profession and will serve the engineers and contractors better than either journal could alone.

LEWIS J. JOHNSON

Professor of Civil Engineering, Harvard University

The best piece of news in engineering circles that I have seen for many a long day is the announcement that the "News" and the "Record" are to combine. I can speak with enthusiasm about the combination, owing to the fact that I am one of the Harvard professors actively engaged in the co-operation between Harvard and Technology. In a very striking sense, it is true that "in union there is strength" and, I believe, in such cases, permanent increase in effectiveness.

A. MARSTON

Dean, Division of Engineering, Iowa State College; State Highway Commissioner, Ames, Iowa

I have learned of the coming consolidation of "Engineering News" and the "Engineering Record" with mingled emotions. Both are old friends. I have taken "Engineering News" ever since my student days and began with the "Engineering Record" about 1896. I shall miss them in their old form.

I once tried to get along without the "Record," but soon found it impossible. Each journal contained many exclusive articles which I could not afford to lose. Hence, I am convinced that the new journal must be much more than a continuation of either the "News" or the "Record," if it is really to take the place of both in the civil-engineering profession. Otherwise, some successful competitor will inevitably develop to fill the vacant place.

Can the publishers and editors produce a super-journal, equal or superior to the combined value of the separate "News" and "Record"? Every American civil engineer will hope that this may be accomplished. Two journals covering the same field are in many respects as inefficient and inconvenient as were two telephones on each business desk a few years ago.

I am especially interested in the success of the "News-Record" because of its potentialty as an important factor in educating civil-engineering students.

I hope that very attractive concessions in price may be made to student subscribers. Our engineering colleges have much difficulty in finding proper agencies sufficiently powerful to really accomplish much toward developing general professional qualifications in their students. I wish all engineering students could become regular readers of the engineering journals at least as early as their sophomore year.

HENRY HOLGATE
Consulting Engineer, Montreal, Canada

The combination of these two great journals is an event of importance to engineers. Both journals have long been conducted with marked ability and enterprise, and I am satisfied that the combination will gain in effectiveness and will be of greater value to engineers than ever.

M. E. COOLEY
Dean, College of Engineering, University of Michigan

The consolidation of "Engineering News" and the "Engineering Record" is a good example of efficiency from the point of view of both the newspaper and the public. It is practically impossible to find time to read the numerous publications coming to one's desk, and to make one publication do the work of two is on a par with and entitled to the same credit as making two blades of grass grow where only one grew before.

E. M. HERR
President, Westinghouse Electric and Manufacturing Co., East Pittsburgh, Penn.

I note with a great deal of interest and much satisfaction the announcement of the consolidation of "Engineering News" and "Engineering Record." The consolidation of two such prominent engineering papers cannot fail to produce a publication which will be pre-eminent in its field, and the combination of the efforts of the two journals in one will enable their readers to obtain engineering information in a very concise and satisfactory form. I congratulate you on a move which must be very satisfactory to your readers and the engineering profession generally.

WM. PIERSON JUDSON,
Consulting Engineer, Oswego, N. Y.

I think that few engineers have had as much reason as myself to feel loyal and grateful to both the "News" and the "Record," both of which I have taken continuously since 1880; beginning with the "Record" when it was the "Sanitary Engineer" and when it was necessary to add it to the "News" to cover the field.

The values which I have had from each have been great, and I know that the coming young engineers, who also have their own ways to make, will find the combined "News-Record" equally valuable and more accessible.

MILO S. KETCHUM
Dean, College of Engineering, University of Colorado

"Engineering News" and the "Engineering Record" have each independently exerted a remarkable influence in the upbuilding of the profession of civil engineering, and the combined influence of these two great technical journals should be much more effective than when they were working independently.

Some of the distinctive contributions of these two great technical journals have been (1) the setting of a high standard of technical journalism, (2) material assistance in creating a spirit of professional pride among engineers and in adopting rational ethical principles for the profession, (3) assistance in promoting and raising the standards of engineering education, (4) furnishing carefully selected details and descriptions of engineering structures and works so that the files of these papers have become encyclopedias of engineering practice, (5) material assistance in promoting engineering research and in the application of scientific principles to engineering design, (6) encouraging literary work by engineers, both in the preparation of articles and in the preparation of technical books that have been of material assistance in advancing the profession.

With the increased facilities resulting from the combination, "Engineering News-Record" should be able to continue the work of the independent journals and to be of great assistance to the engineering profession in the period of wonderful industrial development upon which we are now entering.

B. F. AFFLECK
President, Universal Portland Cement Co., Chicago, Ill.

I have noted with great interest that the Hill and McGraw companies are going together and that it will hereafter be "Engineering News-Record." I think the proposed arrangement is a very desirable one for everybody concerned—subscribers, advertisers and owners; and needless to say, I wish the enterprise the largest possible measure of success.

M. J. BUTLER
Past President, Canadian Society of Civil Engineers, Consulting Engineer, Montreal, Canada

I am greatly pleased to learn of the consolidation of "Engineering News" and the "Engineering Record." I feel sure this new journal will embody all the good qualities of both and save the busy man much time.

It is easier for me to say that "Engineering News" has been my constant helper and friend since 1880 than to attempt to enumerate the many ways in which it has been of value to me. I have always found it a fair paper, dealing justly and courageously with controversial matters, and I hope that the consolidated paper will be a great success.

GEORGE H. FENKELL
Commissioner of Public Works, Detroit, Mich.

It is with great pleasure that I learn of the consolidation of "Engineering News" and the "Engineering Record." I fully realize that it will work in many ways to the advantage of the engineering profession generally. But it is not exactly plain to me how it will be possible for you to raise in any degree the high standard that has been set by each of these papers.

My experience has been that of an official interested in advertising; that of an engineer interested in the profession of engineering generally; and finally that of the individual reader. In each of these lines the papers under discussion have reached a point relatively much in advance of the leading papers of other professions. I believe it is due largely to their excellence that engineering has reached as high a plane in the United States as we find it has today. Progress in any branch of learning must depend on education, gained first in the schools and universities and then by constant reading.

Engineers among my acquaintance have made use of "Engineering News" and the "Engineering Record" almost exclusively, to keep abreast of the times in business and professional affairs; and in nearly all the engineering offices bound copies of these papers are kept for ready reference. A successful and prosperous career for the new publication is guaranteed.

Big Figures Mark Year's Reclamation-Service Work

The vast amount of work done by the United States Reclamation Service up to the close of 1916 has been summarized for "Engineering News-Record" by A. P. Davis, director and chief engineer, Washington, D. C., as follows: Water was supplied during the season of 1916 to about 1,000,000 acres of land divided into 23,951 farms. An available storage capacity of 9,000,000 acre-ft. has been provided. Nearly 11,000 miles of canals and drains have been dug, 77,000 canal structures, 5600 bridges, 6600 culverts, 385 miles of pipe lines, 95 miles of flumes, 2800 miles of telephone lines and 438 miles of electric-power transmission lines have been built. Tunnels to the number of 91, with a total length of 25¾ miles, have been constructed. Storage and diversion dams to the number of 100, requiring 13,000,000 cu.yd. of material, have been built. Of these dams 42 were of masonry, totaling 2,000,000 cu.yd.; 39 of earth, totaling 10,000,000 cu.yd.; and 19 of crib and rockfill type, totaling 1,000,000 cu.yd. An item of excavation to the amount of nearly 150,000,000 cu.yd. completes the summary.

HINTS FOR THE CONTRACTOR

Details Which Save Time and Labor on Construction Work

Set Up Mixer So It Will Come Down Without Yard of Spill Frozen to It

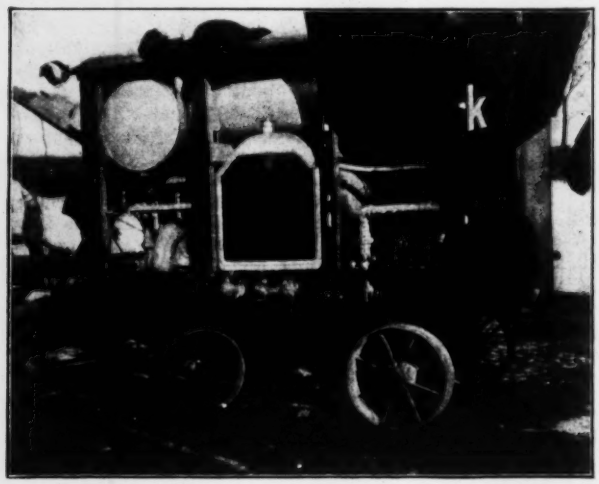
By SAMUEL WARREN
New York City

THE CONCRETE mixer on building work is usually set down in a hole and the loading platform built around it. The wet concrete spills on it, is difficult to get at and sets up hard on the mixer. It is then a great deal of work to clean the mixer when the job is over. To prevent this, if the mixer is given a coat of heavy grease when it is first set up, any concrete that falls on it can be easily knocked off with a hammer at the end of the job, cleaning the mixer in a few minutes.

In setting up the mixer it is best to bed in a lean concrete the timbers on which it rests. Such a setting gives the mixer stability, prevents it from getting out of alignment and cuts down the vibration. It is also found advantageous to leave a depression under the discharge chute, so that any concrete spilled during the day can be removed with a hoe before it sets up or the pile gets big enough to interfere with operation of the mixer.

Home-Made Emergency Portable-Pump Outfit Unwaters Manholes

A PORTABLE centrifugal-pump outfit to unwater manholes has recently been put together in the shops of the Lincoln Park Commission, Chicago, for use in draining the electrical underground distribution system. The equipment is mounted on low wheels and can be hauled by an automobile or a truck. The 12-hp. 1500-r.p.m. marine-type gasoline engine is direct-connected to a centrifugal pump rated at 500 gal. per min. at 2000 r.p.m. Accessories to the pump and engine are a 23-gal. gasoline tank, 5-gal. automobile radiator, a 20-gal. circulating-system tank and a 66-gal. primary tank. With the available speed, 4-in. intake and 3-in. discharge hose, 300 gal. per min. can be pumped against a 15-ft. head, including suction and discharge, but water may be lifted 30 feet.



HINGED COVERS GIVE EASY ACCESS TO HOME-MADE PUMP—RADIATOR IS FOR GAS ENGINE

Control of the entire outfit, including the spark and gasoline levers, the outlet and air-vent valves and the valves on the circulating system, are all grouped at the front end of the machine within easy reach of one man.

Another feature is that means has been provided for obtaining easy access to any part by making the inclosing walls either hinged or entirely removable. Although the pump has been in operation but a few weeks, it has proved its value in pumping dry a line of ten 3-in. ducts that lie along the shore of Lake Michigan and are arranged to drain from one manhole to another.

A detailed statement of the cost of constructing this outfit in the shops of the commission under the direction of C. H. Shepherd, electrical engineer, is given in the accompanying table.

COST OF BUILDING EMERGENCY WATER PUMP

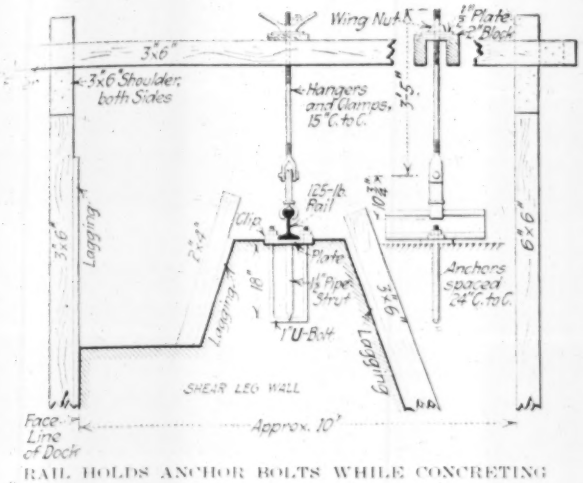
Material	
1 marine engine and muffler	$90 00
1 radiator	25 00
To build truck for engine pump and wheels	225 30
To install engine on pump truck	69 07
Painting pump truck	21 54
To supplying suction hose, valve and fittings	125 89
3 1¼-ft. valves	2 82
1 cap	10
12 bolts, various sizes	12
5 pipe plugs, various sizes	36
5 bushings, various sizes	45
12-ft. water pipe, various sizes	2 34
28 nipples, various sizes	2 24
4 tees, various sizes	50
6 unions, various sizes	09
56 screws and nuts, various sizes	1 00
19 ells, various sizes	1 61
6 padlocks, various sizes	6 60
Miscellaneous material	24 13
Total	$599 86
Labor	
Mechanic, 31 hours @ 50c	$15 50
Helper, 104 hours @ 32c	33 28
Total	$48 78
Garage expense (overhead)	120 85
Grand total	$769 49

Permanent Rail Used in Place of Templet To Hold Anchor Bolts While Concreting

By R. W. REED
Buffalo, N. Y.

THE SKETCH shows a method of setting U-bolts to hold down track rail, by which much time was saved over spacing the rail with templets in constructing track for ore bridges at the Buffalo dock of the Donner Steel Co. Altogether, 2400 ft. of 125-lb. rail was laid in this way. It is anchored by 1-in. U-bolts 24 in. apart, the ends of each bolt passing through a bedplate on which the rails rest, and the nuts on each side holding down cast-iron clips that retain the rail. To space these anchor bolts, templets of 2-in. pine were first used, but the method was abandoned after the completion of the first 120 ft., because it delayed concreting and there was difficulty in maintaining the bedplates at the proper elevation.

The method shown in the sketch, which involved hanging the rail in place before concreting, was substituted.



RAIL HOLDS ANCHOR BOLTS WHILE CONCRETING

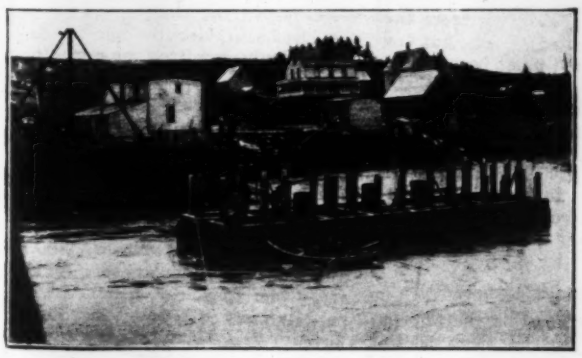
A pipe spreader is used at each anchor, as shown in the sketch, to hold the bolt, bedplate and clips in position. The rail is leveled by the wing-nuts at the top of the hanger rods and lined by slipping the block under each of these nuts one way or the other, before concreting. While the concrete is still green, the top of the rail is checked for grade. Short 1 x 4-in. spreaders from the form studs to the web of the rail hold the latter to line.

Locomotive Tows Caissons to Place in Treacherous Tidal River

By C. H. HOLLINGSWORTH
Consulting and Construction Engineer, St. John, N. B.

THE CAISSONS launched for the bridge at Moncton, N. B., described on page 76 of this issue, were quickly and easily towed to place by a locomotive at slack tide and moored before the treacherous currents of the Petitcodiac River had an opportunity to carry them away.

When the first caisson was completed, it was lowered by jacks to sliding ways of 12 x 12-in. timber 24 ft. long. Each of these ways rested on one of the four main ways, which were spaced on 14-ft. centers under the caisson, giving an overhang of 13 ft. at each end. The main ways, which were braced and blocked continuously, had a slope of about 1 to 9 and were run into the ground at the lower end to prevent their sliding. The struts between the main ways were weighted with rails to keep the ways from floating at high water. The forward ends of the sliding ways were also weighted with rails to sink them as the caisson floated, when they were pulled clear by lead ropes attached to their rear ends.



FLOATING CAISSON TO PLACE

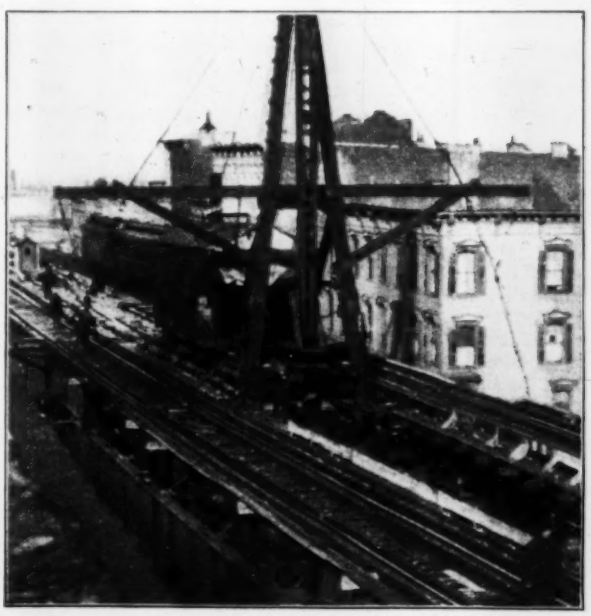
The caisson was launched one hour before high tide, while the current was still running in slowly. As expected, it reached the end of the ways before floating, giving time to get a 1¼-in. steel towing line aboard before the tide rose sufficiently to carry it clear of the ways.

This line ran through snatch blocks on scows moored at pier 3 and at the site of the caisson, and was led from there to a third sheave in line with a siding on the opposite shore, where the line was attached to a switch engine. As the caisson floated, the locomotive started slowly, pulling it over to the first scow at pier 3. The shackle pins on the mooring lines of this scow were knocked out and scow and caisson together hauled over to the second scow. The latter, moored near the location of the pier, had on board the anchor lines up and down stream. These were quickly transferred to the caisson, which was then dropped downstream to approximate position. The entire operation was completed before the outgoing tide interfered.

Guy Traveler Derrick Across Operating Tracks in Rebuilding Elevated Railway

By GEORGE D. FRIED
New York City

THE PHOTOGRAPH shows plainly the way in which a traveler derrick between the outside tracks of the Broadway Elevated R.R., in East New York, Brooklyn, was guyed for lifting heavy loads without interrupting train movements. In the reconstruction of this section of the elevated road, it was necessary for this traveler and one on the ground to raise 27-ton plate girders.



HORIZONTAL FRAME SPREADS GUYS ACROSS OPERATING TRACKS

The work was done for the New York Municipal Ry. Corporation, A. J. Fearing, division engineer, by the Crenshaw Engineering and Construction Co., Inc., under the direction of Henry Mason, erection superintendent.

NEWS OF THE WEEK

Current Events in the Civil Engineering and Contracting Fields

New York Engineers Are Organizing Regiment

War Department Has Assigned Col. McKinstry, Corps of Engineers, To Command New Unit—Enrollment Office Has Been Established

ENGINEERS of New York City and vicinity, acting upon authorization received from the War Department shortly after President Wilson's declaration of a state of war between the United States and Germany, have set in motion machinery for the organization of an engineer regiment, the first unit of its kind outside of the regular army service. Col. C. H. McKinstry, Corps of Engineers, U. S. A., will be the commanding officer, while the battalion commanders will be Majors William Barclay Parsons and Arthur S. Dwight, both of the Officers' Reserve Corps. Capt. X. H. Price has been detailed by the War Department to assist Colonel McKinstry and the Military Engineering Committee at office headquarters. Already a call for enrollment in the new organization has been issued, office headquarters established on the seventh floor of the Enginering Societies' Building, 29 W. 39th St., New York City, with Dr. Joseph Struthers in charge as office manager, and the cost of recruiting and certain other expenses underwritten by members of the Military Engineering Committee of New York, through whose initiative the new engineer regiment is rapidly taking form. A recruiting station will soon be established. Early this week, before the enrollment blanks had been sent out in large numbers, 150 men had signified their intention of joining the new organization.

Need Men for Ranks

The regiment, to consist of 37 officers and 1061 noncommissioned officers and enlisted men, is already well provided with commissioned officers, some from the Corps of Engineers and others from the Officers' Reserve Corps. The immediate need is for men to fill up the ranks—men with construction and shop experience. Already requests have been issued to the General Contractors' Association of New York and to the various labor organizations asking their co-operation in supplying recruits. In addition a call to assist in the movement of filling the ranks with men having practical experience as contractors' employees, mechanics, etc., has been sent to the national engineering societies and to New York's engineer clubs and organizations.

The new regiment, according to an announcement of J. Waldo Smith, Chairman of the Military Engineering Committee of New York, offers an opportunity for patriotic and useful service, particularly to employees of contractors. The committee, representing the engineering profession in the metropolitan district, is sending out circulars and is asking members of various engineering organizations to distribute them among employees and acquaintances. There has also been prepared a provisional enrollment blank, to which signatures are desired so that when a call for volunteers comes, the regiment may be the first in the field. Final action on the organization of the regiment, of course, must wait upon the action of Congress which now has before it the Army bill.

Co-operation Urged

The following organizations have been requested to appoint members with whom the Military Engineering Committee of New York can co-operate: General Contractors' Association, Municipal Engineers of New York City, Engineers' Club, American Society of Civil Engineers, American Institute of Mining Engineers, American Society of Mechanical Engineers, American Institute of Electrical Engineers, American Institute of Consulting Engineers. In addition, the following organizations have been asked to co-operate with the Military Engineering Committee, although they will not have official representation in the latter body: Brooklyn Engineers' Club, and the local engineering societies of graduates of Harvard, Princeton, Cornell, Yale and Massachusetts Institute of Technology.

The Military Engineering Committee's plans are based upon the assumption that all the officers and from 5 to 7% of the men will be drawn from the ranks of professional engineers, but the great bulk of the men must be enrolled from the ranks of men skilled in the various trades—mechanics, carpenters, machinists, railroad men, contractors' employees, etc. It is pointed out that any method of selective conscription would be impossible to carry out in recruiting engineer troops, because the men desired would probably not come within the age limit of 18 and 23 years.

Latest Equipment Desired

Due to the enormous strain put on the administration by the proposed increases in the army, it will, it is thought, be impossible to depend upon the War Department to furnish many essential items for a long time to come, and these the Military Engineering Committee of New York hopes to supply to this regiment.

The Committee expects to expedite the organization and training of the regiment, and to provide, without delay, certain modern equipment most urgently needed. The members of the Committee have agreed to underwrite a sum for this purpose. The feeling, among its members, is that the regiment is to represent the engineering, contracting and manufacturing interests of New York, and as such should be a model for the entire country.

Enrollment Blanks Prepared

On account of lack of authority the committee is not authorized to receive actual enlistments in the new regiment. It is, however, providing enrollment blanks which read as follows: "So far as I can now see I will enlist in the First Regiment, Reserve Engineers, when that regiment is called by the President for service as a volunteer regiment." The application blank then goes on to state the kind of men wanted, as follows: "Physically sound and active men who are citizens or who have declared their intention to become citizens, trained as powder men, carpenters, dock builders, blacksmiths, plumbers and pipe fitters, electricians, engine men (steam and gas), firemen, machinists, masons, calkers, riggers, horse-shoers, saddlers, cooks, chauffeurs, draftsmen and surveyors."

The pay for enlisted men ranges from $75 a month, the maximum for "master engineer, senior grade," to $15 for a private. All equipment, clothing, subsistence and transportation are furnished by the United States.

Work Done to Date

Summing up the work of the Military Engineering Committee of New York, the following are the results to date:

1. Circulars to the number of 15,000 have been printed, soliciting enrollment.

2. An office has been established in the Engineering Societies' Building, New York City, and Dr. Joseph Struthers has been placed in charge.

3. A subcommittee on recruiting has been created, its members being Robert Ridgway, Engineer of subway construction, Public Service Commission, New York City; John W. Lieb, Vice President, New York Edison Co.; Richard S. Buck, Engineer, Maintenance-of-Way, New York Railways Co.; Walter J. Drummond; F. J. MacIsaac, President, General Contractors' Association; F. L. Cranford, contractor; W. S. Menden, Chief Engineer, New York Municipal Railway Corporation; Robert K. Tomlin, Jr., Managing Editor, "Engineering News-Record." The work of

the recruiting committee will include also the matter of publicity.

4. A finance committee has been appointed, headed by Charles F. Rand, the Vice Chairmen consisting of George Gibbs, of J. Parke Channing, Gano Dunn, Arthur S. Dwight, Alex. C. Humphreys, Charles Warren Hunt, John W. Lieb, John R. MacArthur and William Barclay Parsons. The treasurer is William H. Wiley. In addition to the vice chairmen, the committee consists of about 125 other engineers prominent in all branches of the profession.

Owing to the resignation of John P. Hogan, who has received a commission as Captain in the Officers' Reserve Corps, J. S. Langthorn, Deputy Commissioner of Water-Supply of the Borough of Brooklyn, has been made Secretary to the Military Engineering Committee. These men will work in cooperation with the Office Manager, Dr. Joseph Struthers.

Committee's Former Work

The organization of the engineer regiment is another evidence of the activity and patriotism of the engineering societies which have their headquarters in New York. In fact, the creation of the Officers' Reserve Corps, provided for in the National Defense Act passed last June, is attributable in large measure to the work of the country's civilian engineer organizations. The idea was suggested to the War Department by a committee of engineers, nearly all of whom were New York men.

In addition to this, the pioneer work done by the Military Engineering Committee of New York in establishing the first course of military lectures, was the forerunner of similar programs throughout the country.

The Military Engineering Committee is headed by J. Waldo Smith, Chairman, Chief Engineer of the New York Board of Water Supply. The other members are: J. J. Carty, J. Parke Channing, Alfred Craven, Thomas Crimmins, Gano Dunn, Arthur S. Dwight, George Gibbs, Alex. C. Humphreys, Charles Warren Hunt, F. L. Hutchinson, D. S. Jacobus, John W. Lieb, E. W. Van C. Lucas, Kingsley L. Martin, Ralph D. Mershon, William Barclay Parsons, George H. Pegram, Charles F. Rand, Calvin W. Rice, L. D. Ricketts, Robert Ridgway, W. L. Saunders, Merritt H. Smith, Bradley Stoughton, R. W. Stovel, D. L. Turner, William H. Wiley, and Pope Yeatman.

American Money May Build Chinese Roads

Negotiations for the establishment of a loan from American capitalists to construct the national roads in China, to take the place of the canals, are under way between the Chinese Minister of Finance, at Pekin, and A. W. Ferrin, a special trade commissioner of the Federal Department of Commerce. A bill for the establishment of these roads is now pending in the Chinese Parliament.

Contractors Await War Department's Call for Emergency Construction Work

F. J. MacIsaac, President of General Contractors' Association, Explains How Organization Will Handle Defense Work

Frederick J. MacIsaac, President of the General Contractors' Association of New York, gave to a representative of "Engineering News-Record" this week further details regarding the Association's offer to do emergency construction work for the War Department. As noted in the news section last week, page 58, the contractors of New York stand ready to carry out emergency construction practically at cost.

"In making our offer to Col. Frederic V. Abbott, we were, of course, actuated primarily by patriotic motives. Nevertheless, there is a certain advantage to us in the program that we have outlined. By undertaking the War Department work, even though it is at cost, we can keep our personnel together, and, while there may not be any profit, we will at least not suffer any serious loss."

While no definite location as to emergency work can be given, it is believed probable that the first job the General Contractors' Association may be called upon to perform will be at some of the Government forts on Long Island Sound, or New York Harbor.

It was suggested to Mr. MacIsaac that if the War Department should demand construction work on a big scale, it might bring to a halt such needed improvements as the completion of New York City's subway system, or parts of the Catskill Aqueduct.

"The offer," said Mr. MacIsaac, "is intended to cover only emergency work. We stand ready to help the War Department out of any pressing difficulties, but we cannot, at present, place all of our men and resources at the Nation's disposal without first planning to take care of the work now in hand. For example, we are now able to rush 800 men down to Long Island on fortification work, and we can assign such a job to one of the members of the General Contractors' Association. We would not, however, call upon this single contractor to supply all of the men and materials needed for the work. Each contractor member of the Association would be called upon to furnish a quota of men, together with their own foremen. These units would then be assembled under the general direction of one contractor without making too great a drain upon the organization of a single company."

During the discussion the question of permitting men to work more than eight hours on Government work arose. It is probable that legislation will soon be enacted increasing the working hours on emergency construction. It is expected that the labor organizations will not demand any increase in the rate of pay per hour, although if the work is at a distance from New York the men will probably be paid their carfare. It may, however, be necessary to establish a camp on the job to house the men.

If this work in emergencies is to be done efficiently, according to Mr. MacIsaac, the contractor to whom it is assigned must be left largely to his own resources. There must be a minimum of red tape. If work should be undertaken on a fairly extensive scale, different contractors having experience in different kinds of work will be assigned such work. For example, in the layout of a military camp the men from one concern might devote themselves exclusively to construction of floors for tents, and wooden shacks. Another group would specialize on trenching; another on road building; another on pipe laying.

In Mr. MacIsaac's original letter to Col. Abbott in command of coast defenses of New York, the proposal was to charge cost plus 7½%, this added percentage to cover the use of small tools, field supervision and insurance. Mr. MacIsaac explained that the 7½% charge should not have included insurance, as this is to be taken care of in the lump sum cost. The percentage charge will be merely to cover small tools and field supervision.

F. L. Cranford is chairman of a committee on military construction to be done by the General Contractors' Association and will have charge of the work.

Oakland's Additional Water Supply Under Way

Work is well under way with a large force on the San Pablo reservoir of the East Bay Water Company, which supplies water to Oakland, Cal., and surrounding cities. The waste tunnel, 18½ ft. in diameter, has been driven, and the 2 ft. concrete lining is now being placed. The original earth dam projected by the People's Water Company in 1907 was to be 120 ft. in height. This has been increased to 140 ft., with a corresponding increase in yardage to 1,500,000 and in capacity to 40,000 acre-feet. The Berkeley end of the 14,000-ft. outlet tunnel has been shifted 1½ miles north of the original line, giving a somewhat better location for the proposed 20,000,000-gal. rapid-filter plant.

W. E. Creed is president of the East Bay Water Company, which is a recent reorganization of the former People's Water Company. George H. Wilhelm, chief engineer of the former corporation, is acting general manager of the new one, and A. Kempkey is the engineer in charge of the San Pablo work.

Engineering Organizations Rally To Aid in Nation's Defense

Declaration of War Finds Technical Men United and Classified As to Availability

Since the issue of Apr. 5 further replies have been received to inquiries sent out by "Engineering News-Record" in an attempt to find out what our engineering societies have done, or are planning to do, to aid in the organization of the country's engineering resources, both of men and materials, for national defense. Hardly without exception the replies indicate that either some action has been taken, or will be taken at a special meeting. The constitutions of some societies unfortunately make it practically impossible for them to take action except at regular meetings, which, in many cases, occur only at intervals of several months. But wherever quick action has been possible, there not only has been generous response to the various semiofficial pleas, but much work has been initiated and in no few cases the War Department will have complete classification of engineers in many of the branches of the profession. It is highly gratifying to find that the American engineer is able voluntarily to accomplish such satisfactory results.

Classify Mining Engineers

At the request of the Council of National Defense, the Bureau of Mines, in co-operation with the American Institute of Mining Engineers, and the American Chemical Society, has undertaken a census of mining engineers, metallurgists and chemists, with the view of ascertaining the qualifications and the line of work in which each could be of most service in the time of emergency. Circular letters have been sent to the 10,000 members of the American Chemical So iety, and 5000 to mining engineers and metallurgists who are members of the American Institute of Mining Engineers.

There are a large number of mining engineers and chemists who are not members of either of these societies, and an effort will be made to obtain as complete a list of these as is possible. Over 4500 metal mine operators and 4000 coal mine operators have been circularized, and have been asked to furnish the names of mining engineers, chemists and metallurgists in their employ. The results to be obtained by this census may be briefly stated as follows: It will make available a classified list of chemists, mining engineers and metallurgists, the classification embracing 27 specific groups of industrial chemists, 16 groups of mining engineers and 15 groups of metallurgists. When the census has been completed, it can be easily seen how many technical men versed, for instance, in explosives, dyestuff manufacture, petroleum distillation, dredging, pumping, shaft sinking and the handling of alloys, copper, lead, steel and zinc are available.

Through such methods the Bureau will be in a position to furnish on a very short notice the names of specialists in any branch of the mineral industry, so that in case of necessity these technical men could be placed in industrial plants where they would be of most assistance to the country. Experience in foreign countries has shown that the technical men were able to render vastly greater assistance by being placed in the factories than in the regular army. In addition to the technical classification, there will also be a classification of engineers, metallurgists and chemists according to their experience in foreign countries, and with respect to languages with which they are familiar. Anyone who has not received a card and blank covering these points, may obtain them by addressing the Director of the Bureau of Mines, Washington, D. C.

Universal Service Urged

At a meeting of the Albany Society of Civil Engineers held on Mar. 27, 1917, the following set of resolutions were unanimously adopted: First, that we approve of the act of President Wilson in severing diplomatic relations with Germany. Second, that in consequence of the many lawless activities on the high seas against the persons and properties of citizens of the United States, this country, in our opinion, is now in a state of war with Germany, and Congress should so declare. Third, that while Congress should adopt all emergency measures to safeguard the honor and safety of our country, it should establish immediately a permanent and democratic system of universal military service and training under direct and exclusive Federal control. Copies of these resolutions signed by Edward H. Sargent, President, and E. S. Cullings, Secretary, were sent to the President, to the Secretary of War, the Members of the Cabinet, and to the Members of both Congressional Committees on Military Affairs.

Sanitary Features To Be Covered

A blank form has been sent out to the members of the American Public Health Association, asking for information which is to be placed at the disposal of the National Council of Defense, and the boards of health of the various states. According to S. M. Dunn, Secretary, subcommittees have been appointed to obtain information with regard to the various biological and sanitary supplies, which are apt to be needed in connection with war conditions. It is seldom realized how much sanitation, bacteriology, and the preparation of drugs has to do with successful military operations, but the questionaire sent out by the American Public Health Association goes into particular detail on many of these points; for instance, in referring to laboratory work it asks whether experience has been obtained in foods and drugs, water, sewage, disinfectants, making salvarsan, or substitutes, food and water analysis, diagnostic work, making vaccines, antitoxins, etc.; and inquires under the heading of sanitary engineering, whether experience has been along the line of water supply and purification, or in disposing of sewage and refuse. A rather unusual feature of this questionnaire is covered by the suggestion that if a member has had experience in accident prevention, in the prevention of occupational diseases, or even in welfare work, he can be of service to the Government in case of war.

List of 113 Questions

According to Richard P. Dana, a consulting engineer of New York City, the Yale Engineering Association of which he is secretary, has prepared with the aid of military and naval experts a list of 113 questions which seem to be very satisfactory in their application and has mailed the list to all members. As an example of the variety of talent and equipment that can be used for military ends, some of the questions are here quoted: Can you ride? Swim? Shoot? Sail a boat? Navigate a ship? Drive an automobile? A motorcycle? A locomotive? A motor boat? A marine steam engine? An aeroplane? Are you familiar with any of the following trades: Carpentry? Steam-fitting? Blacksmithing? Plumbing? Surveying? Drafting? Machine tool operating? Wiring? Rigging? Pattern making? Molding? Boiler making? Shipbuilding? Sheet metal working? Marine engineering? Shop management? Manufacturing or installing of electrical equipment? Power plant operation? Naval ordnance? Handling and storage of explosives? Design of bridges? Construction of buildings? Streets? Roads? Sewers? Water-supply systems? Water fronts improvements? Ships? Do you know shorthand? Typewriting? Signalling by wig-wag? Semaphore? Ardois? Telegraphy? Wireless? Can you operate a telephone switchboard? Do you own a horse? A motorcycle? An automobile? A motor or steamboat? Would you be willing to place such temporarily at the disposal of the Government for quick movement of troops?

Urge Joining Reserve Corps

C. E. Drayer, Secretary of the Cleveland Engineering Society, says that the Cleveland Engineering Society has taken an active part in the preparation for the national defense. The following strong declaration signed by all the members will be sent to President Wilson, and to all senators and representatives: "The undersigned members of the Cleveland Engineering Society urge upon our senators and representatives the early enactment of legislation providing for universal military training.

The principles contained in either the Chamberlain Bill, or the Bill of the General Staff of the U. S. Army meet our approval." A special printed form drafted by Major P. S. Bond and the society's industrial preparedness committee was sent out to all members, and also a blank to be filled in with the record of training and professional experience, accompanied with a letter from the Chairman of the Industrial Preparedness Committee, G. E. Merryweather. All members who are employers of labor in numbers have received a circular explaining the enlisted reserves. A special committee, consisting of Major E. H. Whitlock, Captain J. B. Beardsley and Willard Beahan, has been given charge of the formation of the enlisted reserves. There have been two public military meetings on the society's program this year, the first being a talk by Major W. F. Hase, on the coast artillery service, illustrated by slides and moving pictures, and the second, a lecture by Major P. S. Bond on "War," illustrated with slides. Each meeting had an attendance of approximately 600.

Industrial Preparedness Vital

At the meeting of the Municipal Engineers of the City of New York, Mar. 28, 1917, the following resolution was unanimously adopted: "WHEREAS, the integrity and life of this Nation is dependent upon its ability to successfully defend itself against foreign aggression and attack; and WHEREAS, it is necessary that the Nation be properly prepared to the end that our untrained patriotic volunteers be not uselessly slaughtered, and our country disgraced and defeated; be it, therefore, resolved, that the Municipal Engineers of the City of New York believe that compulsory universal military training should be at once instituted, and that adequate, complete, and immediate preparedness be provided. BE IT FURTHER RESOLVED, that we believe that thorough and complete preparedness in the army, navy, and the industries of the country is vital; anything less is unsatisfactory and inefficient, and may result in disaster to the Nation. BE IT FURTHER RESOLVED, that we hereby declare our absolute and unconditioned loyalty to the Government of the United States, and pledge our support to the President of the United States in protecting American rights."

Copies of these resolutions were sent to the President of the United States, and to the Senators and Congressmen of the State of New York.

William K. Hatt, President of the American Concrete Institute, has informed the "Engineering News-Record" that the question of industrial preparedness, and how the Institute can help, will be brought to the attention of the Board of Directors at their next meeting on Apr. 11. Mr. Hatt says he can say in advance that the Board of Directors will "pledge its support to the Government in any manner in which they can be of service."

Conference on Coöperation Is Open Forum for Society Problems

Delegates Representing 50,000 Engineers Urge National Societies To Make Engineering Council a Democratic Body

With a renewed determination to use the engineering organizations as they now exist and with little or no contention that any new society is needed, the third annual conference on engineering co-operation, which met at Chicago, Mar. 29 and 30, laid down 10 fundamentals, resolved to continue its efforts, but urged the national societies, in planning for the Engineering Council, to make it democratic and undertake the work of the conference.

More than 40 delegates, representing societies with a membership of 50,000, registered. Nearly 300 engineers attended the banquet, which was participated in by practically all the engineering societies of Chicago. Befitting the occasion, the first of its kind in the city, the tentative plans of the Chicago Engineers' Club for a building to house all engineering societies in the city were received with enthusiasm.

Canada and the War

How the Canadian societies met the war crisis, as presented by J. S. Dennis, president of the Canadian Society of Civil Engineers, was easily the most prominent single feature of the conference. A tablet being erected in the society's house in Montreal, on which 786 members are enrolled, indicates the extent to which Canadian engineers responded to the call. The desirability of further development in this country and in Canada along the line of professional unity was hardly debatable in the speaker's mind. He favored a democratic federation of all societies and pledged his support toward bringing in the Canadians.

In answer to questions by Calvin W. Rice, secretary of the American Society of Mechanical Engineers, as to how the special talents of men going into the war were reserved for special uses, Mr. Dennis said it could not be done. "You cannot expect anything else, and you do not want anything else in a democracy." Round pegs will get into square holes, but the man's first duty is to put himself without reservation at the service of the government.

Canadian Local Organization

The development of local branches of the Canadian Society of Civil Engineers was described by Prof. C. H. McLeod, Montreal. This step was necessary in view of the great territory included. There are now 10 of these branches. They have an intimate corporate relationship with the main society and interest themselves in general professional affairs, but they are practically independent local societies so far as their professional activities are concerned. By their attention to local engineering matters they establish a link between the engineering profession and the public. The main society has sections representative of the four main divisions, mechanical, electrical, mining and general, this last comprising what is usually understood as "civil" engineering in its narrower sense. Some of the larger branches also have similar sections.

The general, or Dominion, Government has no authority over professional affairs, and any legislative control desired must be obtained separately in the several provinces. Both Quebec and Manitoba have acts governing the practice of civil engineering. The latter has no penalty clause and is consequently inoperative. The former has a penalty clause, but permits all members of the Canadian Society of Civil Engineers to practice within the province.

Professor McLeod considers that further legislative control of engineering practice is a certainty. As an indication of this, the society (under strong pressure) has made provision for the establishment of provincial divisions, and such organizations are already in operation in Alberta and British Columbia. The object appears to be to exercise control over legislation, securing the combined advantages of local knowledge and of the co-operation of the profession throughout the whole of Canada. While there is a wide range of opinion in the society as to legislative control, there is universal support of insistence upon advanced educational requirements for admission to membership in the society.

Functions of Engineers' Clubs

The field of action for an engineers' club was outlined by F. G. Jonah, president St. Louis Association of Members American Society of Civil Engineers. He considers that its principal function is to afford a common meeting-ground for the different branches of the profession, through which they can work for the professional improvement of their members, the advancement of engineering, the enhancement of the profession in public opinion and the solution of public questions involving engineering and scientific consideration.

He instanced the Engineers' Club of St. Louis, the pioneer in the movement, as an illustration. This includes local sections of four of the national societies, and its membership of 634 is divided as follows: 55% civil, 26% electrical and the remainder mechanical. Its proceedings are not confined to technical subjects. Thus, at a recent meeting a proposed workmen's compensation law was discussed by the author of the bill and by a lawyer opposing it. The club acts to some extent as an employment agency, being in touch with large employers of engineers and with men available for positions.

The club maintains several committees, which watch over municipal and state legislation affecting their several fields. It is frequently requested to co-operate with the municipal authorities. The Committee on City Building Code has worked with the building commissioner on a revision of ordinances governing building construction, and the Committee on City Plan is considering the rehabilitation of the waterfront, by request of the City Plan Commission. The mayor has a Conference Committee, which suggests the advisability of undertaking improvement work that should be paid for by bond issues. Of thirty-one members, five are engineers, members of the club. The club recently petitioned the governor for recognition of engineers in the appointments to public commissions. A new good-roads law provides for a state highway engineer at $5000 and two assistants at $2500 each. It is believed that the club, representing over 600 engineers, can be more effectual than individuals in impressing the community with the importance and value of engineering.

A Civic Federation of Engineers

Suggestions for engineering co-operation to exert influence on broad public questions usually recommend action either through existing societies or through some new and separate organization. The latter was the basis of a proposition by William L. Saunders, Chairman of the Naval Consulting Board, who advocated the organization of an Engineering Civic Federation, made up of engineers in all parts of the country. This federation would have county organizations, the several county chairmen electing state councilors, and the state councilors electing a president. Subjects relating to county or state interests would be considered by the respective local members. Matters of national importance would be considered by the entire organization, its opinion being expressed only through a referendum.

Employment Gets Attention

At the end of E. E. Olp's paper on "Employment, How It Is Accomplished," describing the machinery of an employment agency serving a high-grade clientele, suggestions were made to have a national committee on employment of all engineering societies with subcommittees in the larger centers, employing a paid secretary. Publicity could be obtained through the technical journals. Not only is the aggregate loss of wages to men between positions enormous, but it is paralleled by an amount equally large lost to employers because of the inability to secure help when needed.

Need for such a widespread body was emphasized by officers of the American Association of Engineers, which has done so much along this line. The mere placing of men is a small part of the problem. Statistics as to supply and demand covering the whole country are greatly to be desired, along with a proper registration of the qualifications of all engineers and a continued education of the engineer in marketing his ability. An offer was tendered to turn over to any properly constituted national body the whole association, for it was designed to do only those things of material welfare not now done. Its present growth of 100 per month, added to its enrollment of 1700, is indicative of the uncultivated field.

Of the 15 fundamental principles proposed by last year's committee, 10 were unanimously adopted with slight modification. Prof. F. H. Newell and C. E. Drayer were reappointed chairman and secretary respectively of an administrative committee of five, three to be appointed by the chair, to continue the work outlined and to provide ways and means for its accomplishment.

STATEMENT OF THE OWNERSHIP, MANAGEMENT, ETC,. REQUIRED BY THE ACT OF CONGRESS OF AUGUST 24, 1912,

of Engineering News-Record, published weekly at New York, N. Y., for April 1, 1917.

State of New York } ss.
County of New York }

Before me, a Notary Public in and for the State and County aforesaid, personally appeared Chester W. Dibble, who, having been duly sworn according to law, deposes and says that he is the Assistant General Manager of the McGraw-Hill Publishing Co., Inc., Publishers of Engineering News-Record and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management, etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, embodied in section 443, Postal Laws and Regulations, printed on the reverse of this form, to wit:

1. That the names and addresses of the publisher, editor, managing editor and business manager are:

Publisher, McGraw-Hill Publishing Company, Inc., 10th Ave. at 36th St., New York, N. Y.

Editor, Charles Whiting Baker, 10th Ave. at 36th St., New York, N. Y.

Managing Editor, Robert K. Tomlin, Jr., 10th Ave. at 36th St., New York, N. Y.

Business Manager, William Buxman, 10th Ave. at 36th St., New York, N. Y.

2. That the owners are:

McGraw-Hill Publishing Company, Inc., 10th Ave. at 36th St., New York, N. Y.

Owners of 1% or more of Stock Issued.

James H. McGraw, 239 W. 39th St., New York, N. Y.

Arthur J. Baldwin, 10th Ave. at 36th St., New York, N. Y.

Edward J. Mehren, 239 W. 39th St., New York, N. Y.

Fred R. Low, 10th Ave. at 36th St., New York, N. Y.

Fred S. Weatherby, 1600 Beacon St., Brookline, Mass.

3. That the known bondholders, mortgagees and other security holders owning or holding 1 per cent. or more of total amount of bonds, mortgages or other securities are: Bondholders, James H. McGraw, Arthur J. Baldwin, Henry W. Blake, Imogene Whittlesey, Hugh M. Wilson, Fred R. Low, Fred S. Weatherby, John McGhie, G. Eugene Sly, Estate of John A. Hill.

4. That the two paragraphs next above, giving the names of the owners, stockholders and security holders contain not only the list of stockholders and security holders as they appear upon the books of the company, but also in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting, is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other person, association or corporation has any interest direct or indirect in the said stock, bonds or other securities than as so stated by him.

CHESTER W. DIBBLE,
Assistant General Manager, McGraw-Hill Publishing Co., Inc.

Sworn to and subscribed before me, this 31st day of March, 1917.

[Seal.] PHILIP S. HILL.

(My commission expires March 30, 1918.)

College Graduates Classified in Military Census

The Intercollegiate Intelligence Bureau is collecting for the Government information as to men available for national defense among the graduates of 80 American colleges. The bureau was organized on Feb. 10 at a meeting held in Washington, D. C., attended by delegates representing 50 or more American colleges. The movement was initiated by Dr. William McClellan, dean of the Wharton School of the University of Pennsylvania and vice president of the American Institute of Electrical Engineers. At the Washington meeting the organization was effected, and plans were made for taking a census of college graduates available for any sort of public service in case of war. Each college is now sending out to its alumni blanks to be filled out, giving full information regarding their business and technical qualifications, and military experience if any. Each man is asked whether he is willing to accept enrollment for duty in an emergency and in what capacity he would consider himself most useful if called into service. Each college will classify the answers it receives and report to the Washington office of the bureau. The Government can at any time ascertain from the bureau where it can find men for any sort of duty when it needs them.

Personal Notes

J. Roy Pennell, of Anderson, S. C., has been elected state highway engineer of South Carolina.

Jesse H. Sinclair has been elected city engineer and surveyor of Burlington, Vt., to succeed his father, the late F. O. Sinclair.

Mark R. Lamb, South American manager of the Allis-Chalmers Co., who was recently heard from at Oruro, Bolivia, expects to reach New York during the month of April.

Crosby J. McGiffert, for the past four years assistant town engineer of Montclair, N. J., has become associated with Edgar S. Closson in the practice of engineering at Montclair.

Hugh L. Conway, assistant city engineer in charge of streets and sewers of Cincinnati, Ohio, has resigned to accept a five-year contract from the Citizens' Road Preserving Company.

C. F. Urbutt has been appointed track-elevation engineer at Chicago for the Chicago, Milwaukee & St. Paul Ry. Co., succeeding **C. H. Buford,** who has been assigned to the Operating Department.

Karl W. Gass, formerly connected with Chester & Fleming, consulting and operating engineers, Pittsburgh, Penn., has been made sales engineer for the Fort Pitt Engineering Co., of Pittsburgh.

Ernest McCullough has resigned as chief engineer of the Fireproof Construction Bureau, Portland Cement Association, to enter the employ of the Stone & Webster Engineering Corporation, Boston, Massachusetts.

Charles L. Harrison, assistant engineer in the Division of Sewerage since 1913, has been appointed principal assistant engineer in charge of the Street and Sewer Repair Division of the Engineering Department of the City of Cincinnati, Ohio.

Ernest S. Alderman, United States junior highway engineer, has been retained by the Beauregard Parish police jury, Lake Charles, La., to supervise the construction of a $500,000 highway system in that section of the state, which will connect with the Calcasieu roads.

Edward H. Thomas, formerly chief engineer of the West India Management and Consultation Co., has been appointed engineer of the Sugar Department of the J. G. White Management Corporation. Previous to his connection with the West India Co., Mr. Thomas was designer and chief engineer of the Sanborn Evaporator Company.

A. P. Dise, recently resident engineer of Brunswick County, Virginia, is now general manager of the Glen Manufacturing Co., Glen Rock, Penn. Mr. Dise has had several years' experience in building construction and railway work in the Eastern and Central States, and before his appointment on the Virginia Highway Commission in 1914 was for two years assistant engineer of the Washington-Virginia Railway.

W. S. Campbell, recently in charge of terminals of the Southern Pacific Co., at San Francisco, has been appointed general manager and chief engineer of the Kentucky & Indiana Terminal R.R. Co., with headquarters at Louisville, Ky. He succeeds J. H. Rightmeyer, resigned. Previous to his employment by the Southern Pacific, Mr. Campbell was for 15 years general yardmaster and superintendent of terminals of the Elgin, Joliet & Eastern Ry. Co., at Joliet, Ill.

Clarence W. Hudson, consulting engineer, New York City, has been selected from a list of 16 bidders as engineer for the new million-dollar bridge to be erected over the Lehigh River between Bethlehem and South Bethlehem, Penn. Mr. Hudson has at various times done considerable bridge designing and constructing for the Phoenix Bridge Co., the Delaware, Lackawanna & Western R.R. and the Lehigh & New England R.R. He was also connected with the construction of the Galveston causeway. In addition to his consulting practice, Mr. Hudson occupies the chair of civil engineering in the Brooklyn Polytechnic Institute.

Edgar S. Closson, for the past four years town engineer for Montclair, N. J., has opened offices in the Plaza Building, Montclair, N. J., where he will carry on a consulting-engineering practice, devoting his attention specially to roads and pavements, sewerage and water systems and related engineering construction. Mr. Closson was graduated from the general engineering course of Union College, Schenectady, N. Y., and has had experience in municipal engineering and railroad construction with the Buffalo & Susquehanna R.R. Co., in subaqueous-tunnel construction and in subway construction with the Rapid Transit Commission and the Public Service Commission in New York City. While in Montclair Mr. Closson organized the engineering department of the town, inaugurated a survey and planned the construction of a system of pavements.

Hiram F. Mills, Hon. M. Am. Soc. C. E., for 22 years connected with the company known as Proprietors of the Locks and Canals on Merrimack River, Lowell, Mass., and since 1894 chief engineer of the company, has resigned on account of advancing years. He graduated from Rensselaer Polytechnic Institute in 1856 and received the degree of A.M. at Harvard in 1889. During the early part of his career Mr. Mills was engaged in hydraulic-engineering work, among the large projects with which he was connected being the Bergen and Hoosac tunnels, Brooklyn water-works and Deerfield dam. He was a member of the Massachusetts State Board of Health from 1886 to 1914, and chairman of the committee of the state board in originating and designing the Metropolitan sewerage system and water-supply. He has been consulting engineer of the Metropolitan Water and Sewerage Board since 1901.

Arthur Truman Safford, who succeeds Mr. Mills, has been assistant engineer of the Locks and Canals during the entire term of Mr. Mills' activities. He has had wide experience in hydraulic enterprises throughout New England and has lectured on hydraulic engineering at Harvard and Yale Universities.

Obituary

Frederick A. Bradley, civil and mechanical engineer, died, on Mar. 31, at Durban, South Africa, where he had resided for a number of years. He was formerly employed at the old Phoenix Iron Works in Trenton, New Jersey.

Gibson Thompson, founder and editor of "The Surveyor," of London, England, died recently after a long illness. The journal named was founded in 1892, and Mr. Thompson was actively connected with it until compelled by serious illness to give up the work some three years ago.

Frank K. Adams, of Seattle, Wash., civil engineer and King County bridge engineer, died on Mar. 25, following an operation for appendicitis. Mr. Adams was born in New York City, in 1856. He went to Seattle in 1903 from Colorado. He built the first Warrenite road in the State of Washington, from Ravenna to Lake Forest Park, in 1909, and drew the first plans of a proposed bridge at 6th Ave., spanning the Lake Washington Canal at Latona.

Duty Green, a pioneer railroad contractor of the West, died recently at Porterville, Calif., at the age of 78. He was born in Marietta, Ohio. After serving through the Civil War, he went to Arizona and took up railroad construction work for the Southern Pacific Co., which was then being extended to the west. He built the first bridge across the Colorado River and the first depot, shop buildings and hospital at Los Angeles, Calif., for this company.

Charles N. Danehower, a well-known contractor and former city engineer of Cincinnati, died in that city on Apr. 8. He was born in Germantown, Penn., in 1849, and moved to Cincinnati when a boy. Mr. Danehower studied civil engineering in the office of the late Gen. Andrew Hickenlooper. After serving as assistant city engineer, he went to Washington, D. C., as a civil engineer in charge of sewerage, under "Boss" Shepard, who laid out that city. In 1880 he returned to Cincinnati to become city engineer and served three terms, under different political administrations, in that capacity.

Appliances and Materials

A 10-Yd. Dredging Bucket

A special dredging bucket of the clam-shell type, having a maximum capacity of 10 yd. and weighing 25,000 lb., is built by the G. H. Williams Co., Erie, Penn. The main hinge pin is a steel forging 9-in. diameter. The corner pins and sheave pins are 6-in. diameter. The high-carbon steel lips are 1½ in. and the scoop plates 1¼ in. The first bucket

TEN-YARD CLAM SHELL

of this class has been bought by the Edward Gillen Dock, Dredge and Construction Co., for levee work at Beardstown, Ill.

A bucket of this type, but of 5-yd. capacity, used by the contractor just mentioned, dug 167,000 yd. of clay on this contract in October, 1916. In 18 working days this same bucket handled 135,000 yd. of clay, and in another month 157,000 yd. of the same material.

Isolated Electric Supply

A mechanically simple automatic ever-ready outfit for the isolated supply of electric current on a comparatively small scale has been developed by the Domestic Engineering Co., of Dayton.

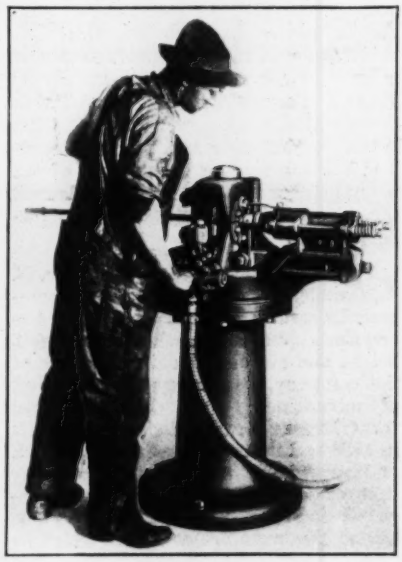
The outfit consists of (1) a compact self-contained engine-and-generator unit and (2) a storage battery. The storage battery supplies current normally, and the engine unit charges back from two or three times a week to once or twice a day, depending on the demand for current. The storage battery is a 16-cell lead type in glass jars, having a capacity of 80 or 160 ampere-hours, as desired. One cell carries a hydrometric ball float to give constant indication of charge-discharge condition.

The engine is a simplified four-cycle type of about 1-hp. capacity and uses gasoline, kerosene or gas fuel. The valves are in the head, and the crankshaft is supported by one ball and one roller bearing. A gear in a sump sprays lubricating oil about the crank case. The carburetor is a simple mixer. For ignition, high-tension current comes from a spark coil fed by the storage battery. The cylinder is air cooled, an overhung turbine fan (and flywheel) drawing air through a draft casing that surrounds the cylinder. The generator (750 watts capacity) is overhung on the crankshaft. An automatic switchboard panel is mounted on top of the generator frame; closing a starting switch feeds current from the battery to the generator (then acting as a motor). When the engine picks up, the battery is automatically charged. When fully charged, the engine is automatically stopped. About 1 gal. of liquid fuel is used for a charging run of 4 to 5 hours. The outfits sell for $275 and $325.

Small Drill Sharpener

A new drill sharpener, of such reduced size and investment that its use is practicable where only two or three drills are employed, is now being made by the Ingersoll-Rand Co., 11 Broadway, New York City. The machine weighs 925 lb. and requires only planking support. It is called the "Leyner Jacksteel Sharpener," and it is limited to round, cruciform, twisted and banded steels of 1⅛-in. maximum diameter, octagon or hexagon steels of 1-in. maximum diameter and square steels of ⅞-in. diagonal. The maximum diameter of bits handled is 2 in. for four, five and six points, and for Z, X and chisel ends; or 1⅞ in. for Carr bits and any having other than 14° taper.

It has a single piston rod on the clamping piston, which arrangement

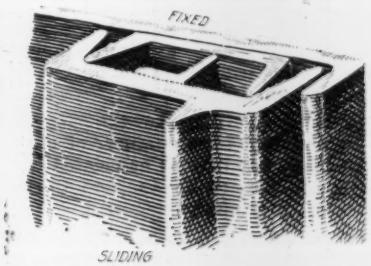


SMALL SHARPENER FOR LIGHT DRILL STEELS

allows locating the die and dolly [illegible] hammer visible to the operator. The die entirely incloses the bit and a single lever controls both clamping and dolly [illegible] ing.

Vertically Sliding Steel Window

A solid steel window that opens by sliding vertically is now being made by the Detroit Steel Products Co. (Fenestra Department), of Detroit, Mich. The



VERTICALLY SLIDING WINDOW

scheme of construction is shown in the accompanying sketch. The sliding section carries a middle angle and is guided by a channel on the frame. By such an arrangement the sash may be allowed to fit the frame loosely, as the air currents have to traverse a labyrinth. This is claimed to give an easy-operating counterbalanced window showing good weather exclusion and slight wear.

Water-Works Service Box

A new and improved service box, for housing shut-off cocks on water-works service lines, bearing the trade name "CMB Box," is being offered by H. W. Clark Co., of Mattoon, Ill. The box proper, housing the cock, is built so that the shut off is always in the center. The notch for service pipes is designed to engage a 1-in. pipe at the bottom and a ¾-in. pipe at the top, giving a wider range of service for the same box. The lower section of the vertical extension is of cast iron, beaded at the top to prevent the sections from separating. The upper sliding extension is smooth, so that the top may be raised and lowered through the action of frost without disturbing the base setting; also, surface loads are not communicated to the service cock or pipe. The top of the extension has a wide flange to give a firm support at the surface of the ground. Underneath the flange is a wide fin to prevent the top from turning. A long screw cap is used in the flange top. One revolution opens and raises the cap 1 in.; a Buffalo key fits the five-cornered head. The screw is in a bronze bushing to prevent rusting fast.

The device is made in 18 sizes, from No. 1, which has an adjustment from 1 to 2 ft. and sells for $1.40, to No. 9½, which has an adjustment from 9½ to 10½ ft. and sells for $2.68.